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A Synthesis of Ecological Data from the 100 Areas of the Hanford Site

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A SYNTHESIS OF ECOLOGICAL DATA FROM THE 100 AREAS OF THE HANFORD SITE

1.0 INTRODUCTION

The primary objective for the development of this document was to collect and synthesize into a single volume Hanford Site-related information of importance to current and future *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) activities conducted in the 100 Areas. The amount of information available is enormous with studies being conducted and reports issued continuously since 1943 (Becker 1990). Our review of this almost 50 years of available data has been exhaustive, but we make no claim that it is all inclusive. The emphasis has been placed in documents of a summary nature as well as broad-based ecological and radiological reports. The purpose here has been to emphasize the breadth of work having been conducted, providing the sources of this information and providing the interested researcher the opportunity to seek more detailed information from the more specialized reports. Thus, this report should be a springboard for discussion, from which more focused evaluations can follow.

Complete plant and wildlife species lists for the Hanford Site have been compiled, and information on levels of contamination (as current as possible) in biota is presented. A list of major species has also been proposed. These are species that are structurally or functionally important in the ecosystem, are granted protective management status, provide an environmental service to humans, or serve as a possibly important pathway for contaminant movement. Important feeding and behavioral relationships among major species, where already identified in the literature, have been included. The literature may not thoroughly cover all possible contaminants of concern to the CERCLA project. Some of these contaminants have not been identified yet; others have had little research (e.g., chromium VI).

From this information, potential indicator species--those that might be used to evaluate future prevailing environmental conditions at the Hanford Site--have been suggested. A number of these indicator species may be used to monitor the release of contaminants during remediation activities.

Because of the vast quantity of information available regarding biota on the Hanford Site, and to make review of the two important ecosystems (Columbia River and terrestrial) easier, this document discusses each ecosystem independently. It should be recognized, however, that there is much interchange among these systems and components common to both (e.g., ducks).

A large amount of information is associated with the aquatic resources of the Columbia River, which borders each of the 100 Areas. However, much of the information related to terrestrial ecology has been collected in the Arid Lands Ecology Reserve and 200 Areas. Therefore, that available information is used for reference here with the assumption that most communities in these areas demonstrate a similarity of life forms. Also, unique studies conducted on man-made ponds and ditches in the 200 Areas that could shed light on Columbia River studies are included.

Main sources of data include the Hanford Site Environmental Monitoring Program, conducted annually by Pacific Northwest Laboratory (PNL). This program looks at various parts of the environment (e.g., air, farm products, water, soil and sediment, biota) on and off the Hanford Site and computes the dose to humans from Hanford-related contaminants. The Westinghouse Hanford Company environmental surveillance program analyzes the potential environmental pathways of exposure to onsite workers; for instance, vegetation from reactor areas and contaminants in N Springs. These programs, combined with other studies on the uptake of contaminants, availability and levels of contaminants, toxicity of contaminants, and physical aspects of the ecosystems (e.g., arid climate), help indicate where problems may or may not occur.

We anticipate the following benefits to be derived from the use of this synthesis: a summary paper for the researcher who desires a quick review of the kinds of studies that have been conducted over the last 50 years; a guide to the potential for impact to biota from past contaminant releases, and, if so, the relative magnitude of the impact; informative summaries that can be utilized in the development of risk assessment scenarios and endpoints; summary statements of previous contamination levels and trends in various media for comparison with current and future studies; information overviews for operable unit coordinators, managers, and regulators to be utilized in the decision-making process; and finally a review that will help evaluate proposed projects and studies in light of the work that has already been conducted.

2.0 SITE DESCRIPTION

2.1 COLUMBIA RIVER HABITATS

River flow through the Hanford Reach is controlled by seven upstream dams, the nearest of which is Priest Rapids, about 12 river miles (Rmi) [19 river kilometers (Rkm)] upstream of the 100-BC Area, the farthest upstream reactor area (Figure 1). Flows vary from a minimum of 36,000 ft^3/s to occasionally more than 400,000 ft^3/s. The width of the riverbed through the Hanford Reach area varies from 1,000 to 2,600 ft; the average depth at normal flow is 10 to 40 ft at the BC area. The river elevation may fluctuate daily up to 5 ft as a result of water releases from Priest Rapids Dam. The normal flows range from 3 to 11 ft/s (ERDA 1975).

There are several slack-water areas on the Hanford Reach. Three of the most important are the White Bluffs slough, between the 100-H and 100-F Areas (Rmi 371/Rkm 597); the F Area slough, approximately 1 mi downstream of the 100-F Area (Rmi 367/Rkm 591); and the Hanford slough, at the old Hanford townsite (Rmi 363/Rkm 584 and south of the 100 Area aggregate area). Because the river flow is greatly reduced in these sloughs, sediment and vegetation are more prevalent, and the resident biota change accordingly. For example, smallmouth bass use these sloughs for spawning, and the juveniles of many fish species use them for "nursery" areas. Suspended contamination may also be more likely to settle out in these areas and not be subsequently flushed downriver as rapidly as contamination in the main channel. The east shore of

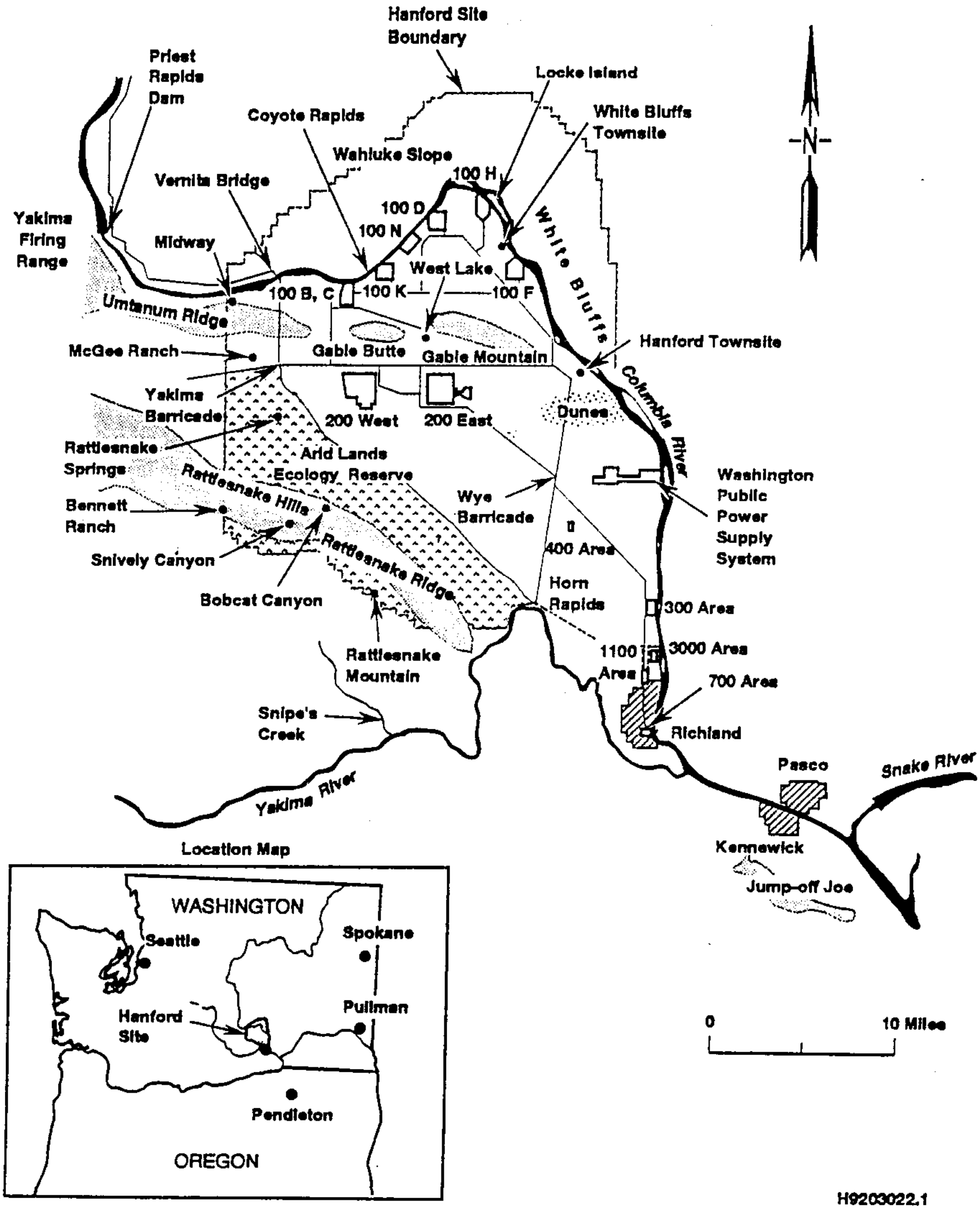

Figure 1. Important Features of the Hanford Site (from Sackschewsky et al. 1992).

the Columbia River, about 1-1/2 mi downstream of the D Area, has also collected sediment during high river flows, similar to the slough areas mentioned.

Springs and seepages flow into the Columbia River from along the shoreline. The most extensive series of these springs extends from the 100-N Area downriver for several miles. Because these N Springs are fed by groundwater contaminated by N Area activities, they and other Hanford Reach springs have been monitored for radioactive contamination (Perkins 1988, 1989; Dirkes 1990; DOE 1992). See Section 5.1.1, "Water and Sediment Contamination."

2.2 TERRESTRIAL HABITATS

The Hanford Site was established in 1943 as a national security area for plutonium production and was subsequently designated as a national environmental research park by the U.S. Energy Research and Development Administration in 1977. In 1968, the U.S. Atomic Energy Commission designated 311 km^2 south and west of Highway 240 as an Arid Lands Ecology Reserve. During the 1970's, about 130 km^2 north of the Columbia River was leased to the U.S. Fish and Wildlife Service for the Saddle Mountain National Wildlife Refuge, and about 220 km^2 north of the river was leased to the Washington State Department of Wildlife to be used for wildlife habitat and outdoor recreation.

The Hanford Site is bounded on the north by the Saddle Mountains, on the east by the Columbia River, and on the south and west by the Yakima River and Rattlesnake Hills, respectively. The dominant features of the Hanford Site include the Rattlesnake Hills (elevation 1,090 m); the Columbia River (and associated aquatic habitats, which act as an attraction and a migration corridor for those species associated with water and wetlands); unstabilized sand dunes located near the Columbia River that are being considered for inclusion as unique habitat; and the basaltic ridges, which interrupt the rolling landscape of the Site and whose ledges provide nest sites for birds of prey.

2.2.1 Surface Soils

Hajek (1966) classified soils on the Hanford Site. The 100 Areas have several soil types: Ephrata stony loam, Ephrata sandy loam, Burbank loamy sand, Rupert sand, and riverwash. Ephrata stony loam is a dark-colored soil with a dark grayish brown medium-textured subsoil underlain by gravelly material. Large hummocky ridges, made of debris from the melting ice of glaciers, typify this soil type. Areas between hummocks contain many boulders several feet in diameter. Ephrata sandy loam also has a dark-colored surface with a dark grayish brown subsoil. This is underlain by gravelly material that may continue for several feet. However, the topography is generally level. Burbank loamy sand has a dark-colored surface with a dark grayish brown coarse-textured subsoil underlain by gravel. The surface soil is usually about 16 in. thick but can be up to 30 in. thick. The gravel content of the subsoil ranges from 20% to 80% by volume.

Riverwash occurs along the northwest tip of the "horn." It forms the islands and occurs in some of the sloughs. Riverwash is wet, periodically flooded deposits of sand, gravel, and boulder. Rupert sand has a brown to grayish brown coarse sand surface. It developed under grass, sagebrush, and hopsage in coarse, sandy alluvial deposits mantled by wind-blown sand. Active dunes and blow-outs occur. The U.S. Department of Agriculture-Soil Conservation Service has reclassified the Rupert sand as a Quincy sand in Benton County.

The capability classifications for these soil types (nonirrigated) vary from Class VI to Class VIII. Class VI has steep relief or is shallow over bedrock and stony; cultivation is not feasible because of wetness or stoniness. It should be used for grazing and forestry but may have moderate hazards for this use and has a high susceptibility for erosion. Class VIII is considered suitable only for wildlife, recreation, or watershed use.

2.2.2 Climate

For general climatological purposes, meteorological data collected at the Hanford Site by the U.S. Weather Bureau from 1912 to 1945 and by the Hanford Meteorological Station from 1945 to present are representative of the Hanford Site. These data were combined into a single set of data for the period 1912 to 1970 by Stone et al. (1972).

The Hanford region is classified as a midlatitude semiarid desert. The climate is strongly influenced by the Cascade Range to the west, which forms a barrier to eastward-moving Pacific Ocean storm fronts. The mountains form a rain shadow, producing mild temperatures and arid climatic conditions throughout the Pasco Basin region.

The mean annual temperature and precipitation at the Hanford Meteorological Station site are 11.8 °C and 161 mm (6.4 in.), respectively. January is the coldest and wettest month with a mean monthly temperature of -1.4 °C and mean monthly precipitation of 23.4 mm (0.92 in.). July is the hottest and driest month with mean monthly temperature and precipitation of 24.7 °C and 3.8 mm (0.15 in.), respectively.

Prevailing winds at the Hanford Site are either from the west-northwest or northwest, with June having the highest mean wind velocity at 4.1 m/s and December having the lowest at 2.7 m/s. Tornadoes rarely occur in the Hanford region and are generally of short duration, with short narrow paths. Tornadoes and funnel clouds have been observed only three times on the Hanford Site since 1916.

3.0 BIOTA

3.1 AQUATIC SPECIES

3.1.1 Flora

Phytoplankton species identified from the Hanford Reach are predominantly diatoms (~90%), golden or yellow-brown algae, blue-green algae, red algae, and dinoflagellates. Plankton occupy a low trophic level in aquatic ecosystems and are predominately primary producers. The plankton populations in the Hanford Reach are strongly influenced by communities that develop in the upstream reservoirs, especially Priest Rapids. The Hanford plankton populations are largely transient, flowing from one reservoir to the next. Endemic groups of plankton do not generally have enough time to develop in the Hanford Reach (Watson et al. 1984).

Dominant phytoplankton genera varied between two sites at Rkm 611/Rmi 380 and Rkm 566/Rmi 352. At Rkm 611/Rmi 380 (near N Reactor), *Asterionella*, *Fragilaria*, *Melosira*, *Synedra*, and *Tabellaria* dominated (together they made up 90% to 95% of the algae), reaching peak populations in summer and a second, lower peak in fall. At Rkm 566/Rmi 352 (near the Washington Public Power Supply System reactor in the 400 Area), *Cyclotella*, *Stephanodiscus*, *Melosira*, *Fragilaria*, and *Synedra* dominated, reaching their peaks of population in spring and again, a lesser peak in fall. See Table A-1 for a list of phytoplankton and periphyton species (Neitzel et al. 1982a).

Periphyton develop on submerged rocks when there is enough light for photosynthesis. Neitzel et al. (1982a) reported dominant periphyton genera at Rkm 566 as *Cocconeis*, *Asterionella*, *Synedra*, *Gomphonema*, *Achnanthes*, *Nitzschis*, *Stephanodiscus*, *Schizothrix*, and *Entophysalis*. Through chlorophyll a measurements, Neitzel et al. (1982a) concluded that periphyton had a greater production in the Hanford Reach than phytoplankton (periphyton had an average of six times more chlorophyll a).

Macrophytes are larger plants, such as watercress and cattail; they provide food, shelter, and breeding areas for fish. However, fluctuating water levels, strong currents, and rocky substrates inhibit the development of macrophytes. Thus, they tend to occur more in slack-water areas, such as the sloughs. See Table A-2 for macrophyte species found in the Hanford Reach. Milfoil, an aggressive, non-native macrophyte, is expanding its range in the Hanford Reach. This fast-growing plant has few natural controls, and may soon affect the character of the river by trapping additional sediments, choking salmon spawning beds, and providing habitat for fish that prey on salmon fry.

3.1.2 Fauna

Neitzel et al. (1982b) examined the zooplankton at Rkm 611/Rmi 380 and Rkm 566/Rmi 352 and identified Bosmina, Diaptomus, and Cyclops as the dominant genera at both locations (Table A-3). Peak densities occurred in summer; yearly lows were in winter.

All major freshwater benthic taxa are found in the Columbia River; dominant genera include caddisfly, midgefly, and blackfly larvae. Limpets, snails, sponges, and crayfish are also present (Table A-4). Population densities of benthic organisms change seasonally and annually. The numbers are lowest in June and July, corresponding with the emergence of adult aquatic insects. Numbers increase dramatically in September and October when the eggs hatch into larvae and stay at moderately high levels from December through April with the overwintering populations (Watson et al. 1984).

Forty-four fish species are reported to occur in the Hanford Reach (Table A-5). The fish species of greatest commercial and recreational importance in the Hanford Reach are salmon and steelhead (WPPSS 1977). The Hanford Reach has been first or second among mainstream and tributary areas of the Columbia River in sport salmon catch for the years 1985 through 1989. In that period, the Hanford Reach catch has averaged 34% of the total sport harvest in the September to October chinook season (NPS 1990). Chinook, sockeye, and coho salmon and steelhead trout use the Hanford Reach as a migration route for upstream spawning areas. The fall chinook salmon and steelhead also spawn in the Hanford Reach (Figure 2). The estimated number of visible chinook redds in the Hanford Reach has increased from less than a thousand during the 1950's to a high of 8,630 in 1987 (Dauble and Watson 1990).

Chinook salmon fry from the fall-spawning adults reside in the Hanford Reach from March through July and migrate downriver as 0-age fish. Chinook juveniles from spring and summer-spawning adults (spawning in areas above the Hanford Site) migrate seaward as large fingerlings in their second year (as the 1-age fish group). Backwater sloughs and shoreline indentations are important rearing areas for fall-chinook fry because of the reduced currents and more readily available foods species. Both salmon and steelhead are heavily fished commercially and recreationally on the Columbia River and during their ocean-going runs.

Steelhead trout have peak migrations in August and September, but a population is present all year. Steelhead trout mature in the ocean at 3 to 6 years and spawn in the Columbia River from late December through May. Eggs incubate in the gravel through June (Bell 1973, as reported in Watson et al. 1984). Steelhead, while like salmon, do not actively feed during their spawning run, unlike salmon, steelhead can survive spawning. Repeat spawners in Washington State are from 4.4% to 14% of the run (Wydowski and Whitney 1979, as reported in Watson et al. 1984). No indication is given whether any Hanford-spawning steelhead return for additional spawning runs because of the obstacles to downriver movement at several dams.

Shad, an introduced fish, are also an anadromous species spawning in the Hanford Reach. In 1956, less than 10 adult shad ascended McNary Dam. Thousands of shad now use the Hanford Reach (Cushing 1991). However, their use in sport fishing or for human consumption is minimal.

White sturgeon are long lived (25 to 50 years, Dauble et al. 1988) residents of the Columbia River, including the Hanford Reach. Their movement is largely restricted by the dams, so adult sturgeon between McNary and Priest Rapids dams will spend their entire lives in that stretch. Female sturgeon mature at 15 years, at a length of about 64 in. and a weight of 60 to 70 lb.

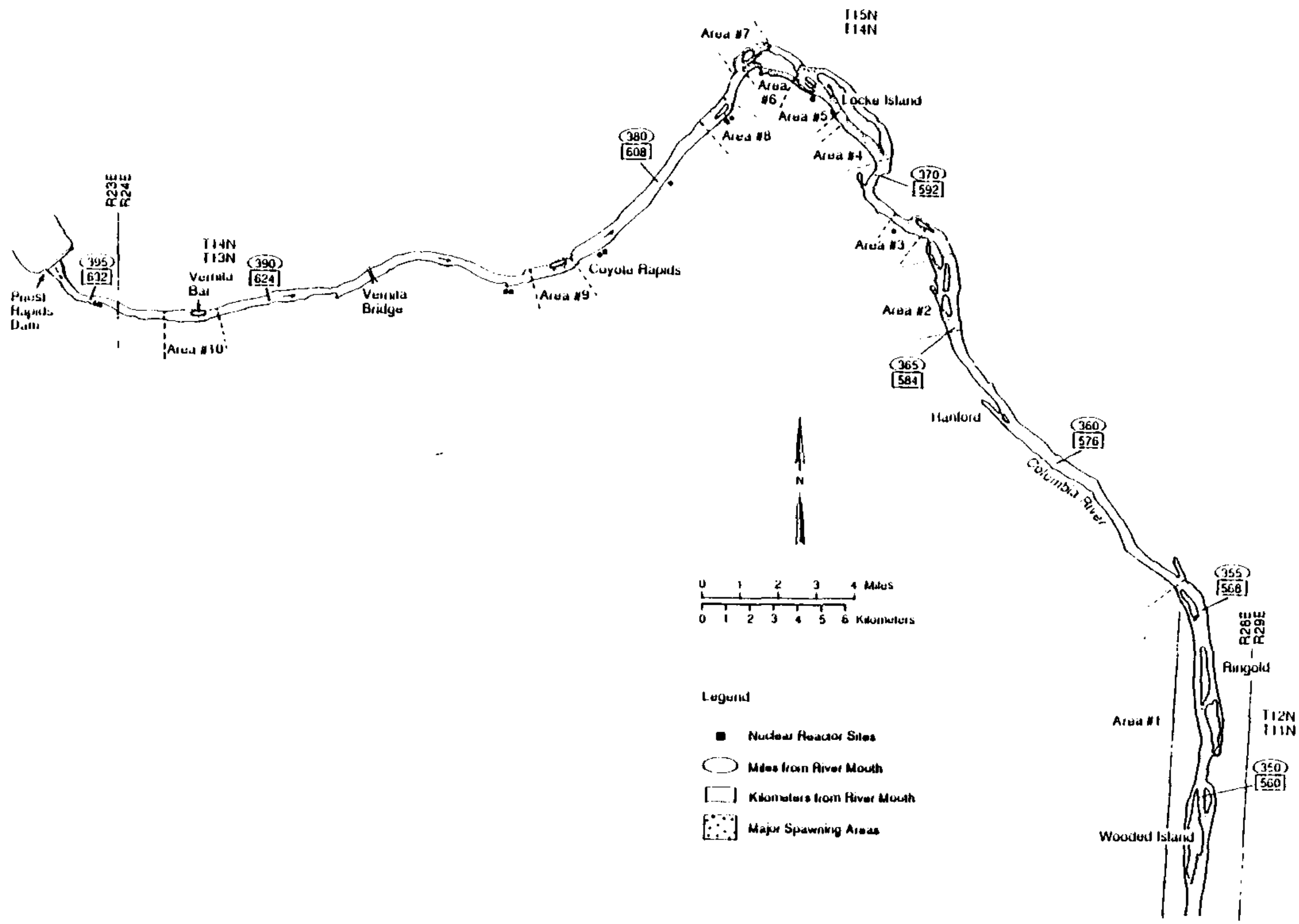

Figure 2. Major Fall Chinook Salmon Spawning Areas in the Hanford Reach of the Columbia River (from Dauble and Watson 1990).

Spawning occurs primarily in May and June, in fast-flowing rocky areas at least 10 ft deep (Watson et al. 1984). Sturgeon fry eat plankton at first, then insect larvae. At about 1 year, they become bottom feeders and eat mollusks, crayfish, fish, and carrion. Fish collected near Rmi 380/Rkm 612 (N Reactor) were found to have eaten crayfish and snails; fish collected at Rmi 352 had eaten fish, midgefly larvae, caddisfly larvae, and crayfish (Gray and Dauble 1976, 1977b).

Smallmouth bass depend on the warmer water temperatures in the White Bluffs, F Area, and Hanford sloughs for spawning (late spring to early summer). However, river flows have an overwhelming influence on bass spawning success and residence in the sloughs, and in many years reproduction is poor because of extreme fluctuations in flows. The adults leave the sloughs at the conclusion of spawning. However, in low-water years [e.g., 1977, when Montgomery et al. (1980) conducted their radiotelemetry study], spawning bass may be locked in the F Area slough and associated ponds for at least a year. In some of the ponds, decreasing water levels in the river causes the ponds to dry up, killing the stranded fish (adults, juveniles, and 0-age) (Montgomery et al. 1980). Smallmouth bass fry eat small crustaceans, graduating to insects, fish, frogs, crayfish, and fish eggs as they grow (Watson et al. 1984).

Mountain whitefish are abundant, year-round residents of the Hanford Reach. They are fished for by sportsmen, primarily in winter (Fickeisen et al. 1980b). Whitefish are primarily bottom feeders of insect larvae, small molluscs, and larvae fish (Watson et al. 1984).

Carp are omnivorous, feeding on plant material, zooplankton, insects, clams, animal fragments, and miscellaneous organic and inorganic matter (Wydowski and Whitney 1979). Carp are a commercial fishery in Washington, but not in the Hanford Reach. They are also occasionally eradicated from local water, e.g., McNary National Wildlife Refuge, because they destroy waterfowl habitat.

Other sport fish occasionally harvested in the Hanford Reach are crappie, catfish, walleye, and perch. Large populations of rough fish include shiners, suckers, and squawfish (Cushing 1991).

3.2 TERRESTRIAL SPECIES

3.2.1 Flora

The Hanford Site, located in southeastern Washington, has been botanically characterized as a shrub-steppe (Daubenmire 1970). Because of the aridity and soil types, the productivity of both plants and animals is relatively low compared with other natural communities. In the early 1800's, the dominant plant in the areas was big sagebrush with an understory of perennial bunchgrasses, especially Sandberg's bluegrass and bluebunch wheatgrass. With the advent of settlement that brought livestock grazing and crop raising, the natural vegetation mosaic was opened to a persistent invasion by alien annuals, especially cheatgrass. Today cheatgrass is the dominant plant on many fields that were cultivated 40 years ago. Wildfires in the area are common; the most recent extensive fire in 1984 significantly altered the shrub component of the vegetation across much of the Site by removing large stands of sagebrush (Cushing 1991).

The dryland areas of the Hanford Site were treeless in the years before land settlement; however, for several decades before 1943, trees such as locust and elm were planted and irrigated on most of the farms to provide windbreaks, orchards, and shade. When the farms were abandoned in 1943, some of the trees died, but others have persisted, presumably because their roots are deep enough to contact groundwater. These trees now serve as nesting sites for several species of birds, including hawks, owls, great blue herons, ravens, and magpies, and as roosts for wintering bald eagles. Other trees, such as mulberry, have become established along the Columbia River as the river flow has become moderated from upriver dam control.

The vegetation mosaic of the Hanford Site currently consists of nine major kinds of plant communities (Sackschewsky et al. 1992):

- Greasewood
- Riparian
- Hopsage
- Sagebrush/bluebunch wheatgrass - Sandberg's bluegrass
- Sagebrush-bitterbrush/Sandberg's bluegrass-cheatgrass
- Sagebrush/cheatgrass - Sandberg's bluegrass
- Winterfat
- Buckwheat
- Cheatgrass.

The distribution of the dominant vegetation types is shown in Figure 3, and a list of common plants (ERDA 1975) is provided in Table B-1 (Appendix B). The cheatgrass/tumble mustard vegetation type is the prominent habitat type within the 100 Areas. Riparian vegetation (e.g., willows and reed canary grass) occurs along the banks of the Columbia River. A more recent cataloging of plant species along the Columbia River, done as part of CERCLA investigations, is in Landeen and Sackschewsky (1992). In addition, a complete species list of all plants on the Hanford Site has been compiled (Sackschewsky et al. 1992).

The release of water used as industrial process coolant streams at the Hanford Site facilities created several semipermanent artificial ponds. The ponds are ephemeral, and some have disappeared as the industrial release of water was terminated. Most of these ponds are in and near the 200 Areas; however, the 100-D ponds, used to receive nonradioactive filter backwash from the 183-D facility, are in the 100-D Area. As of 1991, only one of the two 100-D ponds had standing water and associated riparian growth.

Plants of potential importance in a direct pathway to man in the 100 Areas are those that may be utilized as food by humans. Soldat et al. (1990) identified a number of plant species found on the Hanford Site that could be consumed by humans. Soldat concluded that while the quantity of these plants harvested from the Hanford Site is unknown, it is not likely to be significant because of the restricted access. However, some asparagus and mulberries are known to have been removed from the Hanford Site (see section

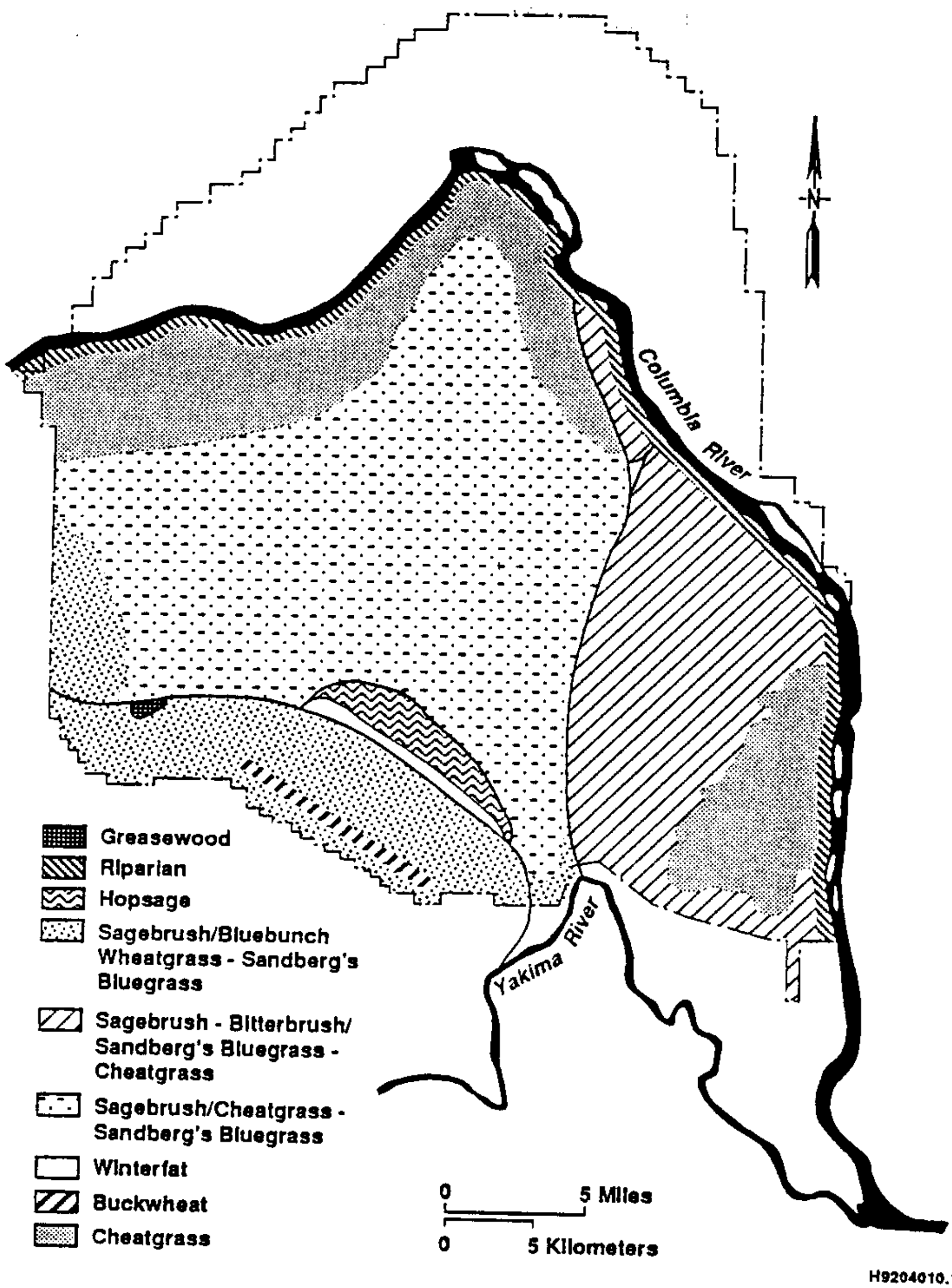

Figure 3. Hanford Site Plant Community Types (from Sackschewsky et al. 1992).

on Known Contamination). Sackschewsky et al. (1992) identified 73 plants that could be utilized by humans as food and 83 as potentially of medicinal use (Table 1).

3.2.2 Mammals

A total of 39 mammal species occupy the Hanford Site (Cushing 1991) (Table B-2). Rickard et al. (1974) identified eight mammals that may be important to management of radioactive wastes in the 200 Areas because of their food habits, behavior, or position in the food chain. They are mule deer, coyote, muskrat, raccoon, badger, Townsend ground squirrel, black-tailed hare, and the Great Basin pocket mouse. The significance of these animals to the 100 Areas is discussed below.

3.2.2.1 Mule Deer. Mule deer are important because they occur in a direct food chain pathway to humans, and Hanford Site deer can easily move offsite and be hunted. Mule deer on the Hanford Site are found predominately along the Columbia River but also occur in the interior of the Hanford Site. Mule deer are strongly associated with open water (preferring areas within 1.25 mi) during all seasons (Eberhardt et al. 1989a). Deer prefer riparian areas because of the availability of forage such as riparian trees (mulberry, Russian olive, cottonwood, and willow), drinking water, and the shade during the summer months. Nearly all the trees along the western bank of the Columbia River show browse lines created by deer (Fickeisen et al. 1980a, Rickard et al. 1982). Washington Public Power Supply System (WPPSS 1977) reported that mule deer and other herbivores subsist mainly on streamside vegetation during the summer.

In August 1977, an aerial census of the islands and southern shore (to 0.8 km) along the Hanford Reach indicated an average of one deer per 58 ha (Steigers and Flinders 1980). Mule deer eat a variety of plants, sometimes changing their food preferences from area to area despite similarities in plant species in different areas (Uresk and Uresk 1980). Big sagebrush and gray rabbitbrush were eaten sparingly, while bitterbrush, willow, Russian thistle, goldenrod, white sweet clover, and Russian olive appeared to be favored in three sites in the 200 Areas. Cheatgrass had a frequency of occurrence of about 50% in all three sites but ranged from less than 0.5% to about 3.4% as a component of the deer fecal pellets.

The migratory habits of mule deer fawns on the Hanford Site have been studied. Mark and recapture of 346 Hanford Site fawns over 9 years (Eberhardt et al. 1979) showed 27 to have died; 21 of these died off the Hanford Site. Fifteen were killed by hunters and two killed by poachers. An earlier report from the same study reported that four of the hunter-killed deer, tagged as fawns on the Hanford Site, were taken far from Hanford: near Mattawa (25 mi upriver), near Wallula Gap (50 mi downriver), in a farming area 20 mi west of the tagging location, and north of Soap Lake (70 mi away) (Hedlund 1975).

The Hanford deer herd consists of more mature individuals than many other herds, with 24% older than 10.5 years, as opposed to 2% to 9% for other Washington deer herds (Eberhardt et al. 1982). This high percentage suggests an essentially nonhunted, nonmigratory herd, despite the tendency for young

Table 1. Hanford Site Edible Plants (from Sackschewsky et al. 1992).
(sheet 1 of 3)

Scientific name	Common name	Plant parts used
Acer saccharinum	silver maple	Sap
Allium sp.	onion	Bulbs
Amaranthus albus	amaranth, white pigweed	Leaves, seeds
Amelanchier sp.	serviceberry	Fruits
Aquilegia formosa	red columbine	Flowers
Arctium minus	burdock	Leaves
Asclepias speciosa	showy milkweed	Flowers, shoots
Asparagus officinalis	asparagus	Young shoots
Atriplex sp.	saltbush	Seeds
Avena sativa	oat	Seeds
Balsamorhiza sp.	balsamroot	Whole plant
Brodiaea sp.	brodiaea	Bulbs
Calochortus macrocarpus	sagebrush mariposa lily	Bulbs
Capsella bursa-pastoris	shepherd's purse	Leaves, seeds
Cardamine pennsylvanica	bittercress	Leaves
Castilleja sp.	indian paintbrush	Flowers
Chenopodium album	lamb's quarters	Leaves, young stems
Cichorium intybus	chicory	Leaves, roots
Cirsium sp.	thistle	Peeled stems, roots
Comandra umbellata	bastard toadflax	Fruit
Crataegus douglasii	black hawthorn	Fruit
Cyperus esculentus	yellow flatsedge	Tubers
Epilobium angustifolium	fireweed	Young shoots and leaves
Fritillaria pudica	yellowbell	Bulbs
Gallium aparine	cleavers	Shoots, seeds
Glycyrrhiza lepidota	licorice	Roots
Helianthus annuus	common sunflower	Seeds

Table 1. Hanford Site Edible Plants (from Sackschewsky et al. 1992).
(sheet 2 of 3)

Scientific name	Common name	Plant parts used
Juglans nigra	black walnut	Nuts
Juniperus sp.	juniper	"Berries"
Lactuca serriola	prickly lettuce	Young leaves
Lepidium sp.	peppergrass	Fruits, seeds
Lewisia rediviva	bitterroot	Bulb
Lomatium sp.	biscuitroot	Roots, seeds
Malus pumila	apple	Fruit
Medicago lupulina	black medick	Seeds
Mentha sp.	mint	Leaves
Microseris troximoides	false mountain dandelion	Roots
Montia perfoliata	miner's lettuce	Leaves
Morus alba	white mulberry	Fruit
Oenothera sp.	evening primrose	Young roots
Opuntia sp.	prickly pear	Fruits, stems
Orobanche sp.	broomrape	Whole plant
Oryzopsis hymenoides	indian rice-grass	Seeds
Panicum miliaceum	broomcorn millet	Seeds
Perideridia gairdneri	Gairdner's yampah	Roots
Plantago sp.	plantain	Leaves
Polygonum persicaria	heartweed	Leaves
Portulaca oleracea	common purslane	Leaves, stems
Prunus sp.	cherries, peaches, etc.	Fruit
Pteridium aquilinum	bracken fern	Young leaves
Pyrus communis	pear	Fruit
Rhus glabra	smooth sumac	Fruit
Ribes sp.	gooseberry, currant	Fruit
Rorippa nasturtium-aquatica	watercress	Leaves

Table 1. Hanford Site Edible Plants (from Sackschewsky et al. 1992).
(sheet 3 of 3)

Scientific name	Common name	Plant parts used
Rosa woodsii	wood's rose	Rosehips, flowers
Rubus discolor	Himalayan blackberry	Fruits
Rumex sp.	dock, sorrel	Leaves
Sagittaria cuneata	wapato	Roots
Salix sp.	willow	Bark, leaves
Salsola kali	Russian thistle	Seedlings
Sambucus cerulea	blue elderberry	Fruits
Secale cereale	rye	Seeds
Scirpus sp.	bulrush	Roots, shoots, pollen, seeds
Solidago sp.	goldenrod	Leaves
Sporobolus cryptandrus	sand dropseed	Seeds
Taraxacum officinale	dandelion	Leaves, roots, flowers
Tragopogon dubius	yellow salsify, goatsbeard	Roots
Triticum aestivum	wheat	Seeds
Typha sp.	cattail	Pollen, roots
Urtica dioica	stinging nettle	Young leaves
Veronica americana	brooklime	Leaves, stems
Vicia sp.	vetch	Fruits
Viola sp.	violet	Flowers leaves

NOTE: Inclusion on this list should not be regarded as a recommendation for consuming these plants.

deer to travel. The main predator of Hanford Site deer, especially fawns, appears to be coyotes (Rickard et al. 1974, Eberhardt et al. 1979).

Eberhardt et al. (1982) reported that 2 of 37 radio-collared deer were shot, 1 illegally near the Washington Public Power Supply System operations in the 400 Area. They concluded that deer used small areas intensively for a while, then moved to another area. Areas near the old towns of Hanford and White Bluffs, and the old orchard north of the 100-D Area, were used heavily by deer. The Columbia River restricted, but did not prevent, deer movements. Six of 14 deer living along the river swam it; 8 of the 37 (both river and inland deer) made at least one trip across (1 deer swam back and forth at least 8 times over 19 months).

Research on Hanford Site deer continues with a multiyear radio-collared and tagged deer study of 100 Area deer. The intent of the effort is to study offsite movements and hunter kill, levels of strontium in the antlers, and the total number of deer in the 100 Areas.

3.2.2.2 Coyotes. Coyotes are the most abundant, widespread, and important mammalian predator on the Hanford Site (Rickard et al. 1974). They may den in burrows made by badgers and are omnivorous, eating plants, insects, fish, reptiles, birds, and mammals, including occasionally adult deer (Rickard et al. 1974, Springer 1982). Stoel (1977, as reported in Springer 1982) reported that black-tailed jackrabbits were 30% of the coyote's diet. In August 1977, a count of coyotes on the islands and south shore of the Columbia River to 0.8 km inland was one coyote per 388 ha (Steigers and Flinders 1980). While Springer (1982) reported that 83% of coyote activity occurred in 7% of the home range area, the total home range sizes averaged 92.4 km^2 (924 ha). The majority of the home range was on the Hanford Site, which is protected land, but almost all of the 10 radio-collared coyotes spent some time off the Hanford Site. Thus, although coyotes are not included in the pathway to humans, radionuclides that coyotes could pick up onsite in contaminated burrows or consume in prey could be dispersed off the Hanford Site.

3.2.2.3 Rabbits and Hares. Steigers and Flinders (1980) reported results (from Vaughan et al. 1977) that the population of black-tailed jackrabbits for the entire Hanford Site was one per 28 ha (one per 69 acres). Stoel (1977, as reported in Springer 1982) reported the density of black-tailed jackrabbits on the Hanford Site as one per 3.6 km^2 (one per 36 ha, or one per 89 acres).

Uresk (1978) studied the diets of jackrabbits on the Hanford Site and found needle and thread grass and yarrow to be the two most favored plants in the sagebrush community, with turpentine cymopterus, hoary aster, rabbitbrush, and Jim Hill mustard also important. Jackrabbits selected against cheatgrass in their eating and were "credited" with helping to maintain cheatgrass stands by consuming the perennial grass competition.

O'Farrell et al. (1973) and Rickard et al. (1974) reported that jackrabbits played a major role in dispersing ^{137}Cs and ^{90}Sr in the B-C Crib Area (200 Areas). Jackrabbits are not expected to swim the Columbia River with any frequency. Their role in a direct pathway to humans is assumed to be slight. Rickard et al. (1974) also report that jackrabbits are rarely eaten by hunters, but road kills are consumed by coyotes, badgers, ravens, magpies, and raptors. None of these animals represent a direct pathway to humans. A study of the demography of jackrabbits on the Hanford Site has begun.

Cottontails are also found on the Hanford Site, but are most commonly associated with riparian and irrigated areas such as lawns (Watson et al. 1984). Cottontails are more frequently consumed by humans than are jackrabbits, but no offsite movement to hunted areas is expected from the 100 Areas.

3.2.2.4 Badgers. Badgers are fairly common on the Hanford Site and Rickard et al. (1974) considered them to be an important animal in relation to dry buried waste. Their deep, large burrows dug to excavate prey can unearth substantial quantities of contaminants. Badgers eat ground squirrels and other small mammals. Gano and States (1982) reported that removal of badger prey species removes the incentive for badgers to burrow. Because of the cobble nature of much of the 100 Area soils, especially near the retired reactor areas, there is light use of these areas by either badgers or their prey.

3.2.2.5 Muskrats. Muskrats occur in backwater areas along the Columbia River. However, the gravelly cobble on the bed of the Columbia and along most of the banks, especially near the retired 100 Area reactors, is not conducive to muskrat habitation. Rickard et al. (1974) considered muskrats important in waste management because they contact pond sediment and eat the associated vegetation. While they tend to be sedentary, their predators (coyotes, great horned owls, and large hawks) can move far from contaminated aquatic areas. They are not in a direct pathway to man. Beavers, however, can be seen along the 100 Area shoreline. They eat riparian vegetation but are also not in a pathway to man.

3.2.2.6 Great Basin Pocket Mouse. Great Basin pocket mice prefer open, shrub-dominated vegetation with an understory of cheatgrass and Sandberg bluegrass. They spend more time below ground than above and become torpid during the summer heat and winter cold. They feed on grass seeds and other vegetation and are in turn eaten by raptors, snakes, and mammalian predators (Rickard et al. 1974). Johnson (1975) reported that more than 35% of the diet of pocket mice on the Hanford Site was *Descurainia pinnata* (Tansymustard); cheatgrass made up only about 7%. Gano and Rickard (1982) trapped 469 pocket mice (12,200 trap nights) in the burned and unburned bitterbrush-cheatgrass community at the 400 Area. Other mouse species captured included 68 deer mice, 15 northern grasshopper mice, and 8 western harvest mice. The populations of all these small mammals were reduced on the burned plot.

Gano and States (1982) evaluated the burrow depths of small mammals in arid and semi-arid regions and reported 35 to 193 cm as the range of depth of burrows for the Great Basin pocket mouse. Gravelly or coarse-textured soils discourage burrowing, thus the low occurrence of pocket mice. Within much of the 100 Areas, the soil is gravelly and/or cobbled, especially near waste-disposal sites. However, some mammal burrowing near waste disposal sites has been documented (Landeen and Sackschewsky 1992).

3.2.2.7 Townsend Ground Squirrel. Townsend ground squirrels are abundant in colonies throughout much of the shrub steppe. However, they are uncommon in the 100 Areas, probably due to the heavily cobbled soils. Gano and

States (1982) noted that these ground squirrels generally occur in dry, light soils. Gano and Rickard (1982), in a study at the 400 Area (in areas of burned and unburned bitterbrush-cheatgrass), trapped only one ground squirrel in 12,200 trap nights. Ground squirrels are active from March to June, spending the rest of the year underground, when plant growth is limited. Their colonies are preyed on by digging predators, such as badgers and coyotes.

3.2.2.8 Raccoon. Raccoons are occasionally found in the riparian areas along the river and are omnivorous, eating fish, invertebrates, plants, snakes, birds, and mammals. They readily adapt to and benefit from human activities, such as garbage in poorly secured cans and pet food kept outside. They may be trapped for their fur away from the Hanford Site and may be of significance mainly because of their omnivorous food habits in the riparian areas. Because their numbers are low, they lack a predator on the Hanford Site, and their meat is not used as human food, no significant contaminant pathway is anticipated from raccoons.

3.2.3 Birds

Landeen et al. (1991) reported 235 species of birds [including birds out of their normal range (accidentals) and unconfirmed sightings] that have been seen on the Hanford Site. The horned lark and western meadowlark are the most abundant nesting birds in the Hanford Site's shrub-steppe. See Table B-3 for a listing of birds as reported by Landeen et al. (1991). In addition, the Lower Columbia Basin Audubon Society has published a list of birds of the Tri-Cities and vicinity, including dates of occurrence and abundance, compiled from 23 years of observations (Ennor 1991).

The Hanford Site supports populations of chukar, California quail, Chinese ring-necked pheasant, and gray partridge. Sage grouse formerly lived on the Hanford Site (Landeen et al. 1991); Eberhardt and Hofmann (1991) report that the most southerly range of the sage grouse in Washington now is the Yakima Firing Center. However, recent reports indicate that some sage grouse occur on the southwest side of Rattlesnake Mountain. Mourning doves nest throughout the Hanford Site. Chukar and gray partridge are most common on the Arid Land Ecology reserve; quail and pheasant can be found near the river in the 100 Areas. All these birds, except the sage grouse, are legally hunted off the Hanford Site and eaten by humans. Their foods include insects and grains (depending on the season and age of the bird). They have the potential to move offsite during hunting season.

Hawks and owls use the Hanford Site as a refuge, especially during nesting. Swainson's, ferruginous, red-tailed and marsh hawks; kestrels and prairie falcons; and barn, burrowing, great-horned, short-eared and long-eared owls have all been recorded as nesting on the Hanford Site (Fitzner et al. 1981). Ferruginous hawk nests have been increasing in recent years, because of the construction of transmission line towers (Fitzner and Newell 1989). In winter, rough-legged hawks and bald and golden eagles are common visitors to the Hanford Site.

A list of birds associated with the riparian community on the Hanford Reach is shown in Table 2. Bald eagles use the Hanford Reach from late November to February, using the trees near the river shoreline for night-time roosting and feeding perches (Fickeisen et al. 1980a). The eagles are attracted to the Hanford Reach because of the availability of carcasses of salmon that die after spawning. Wounded waterfowl, especially mallards, also provide a food source for bald eagles (Rickard et al. 1982). In recent years, the counts of wintering eagles have increased, from fewer than 10 eagles in the 1960's to almost 60 in 1988. In 1989 the count dropped to about 35 birds. The presence of the tall trees near the river, the isolation of the perch sites and foraging areas from human disturbance, and the steady increase in salmon spawning in the Hanford Reach have contributed to the growing numbers of wintering bald eagles (Jaquish and Bryce 1990). In 1991 and 1992, bald eagles unsuccessfully attempted to nest on the Hanford Site (Fitzner et al. 1991).

Resident Great Basin Canada geese use 20 islands on the Hanford Reach for nesting (Rickard et al. 1982, Rickard and Fitzner 1985). See Figure 4. Resident geese eat riparian vegetation and insects and will also feed in agricultural fields. Rickard et al. 1982 reported a drop in goose nests on the Hanford Reach islands (Figure 4) from about 300 in the 1950's to 77 nests in 1976. Movements of goose broods along the river in the Hanford Reach, until the chicks fledged, varied from 2.8 to 18.1 km. These geese preferred to feed in areas which were free from coyote disturbance and near nesting sites with gently sloping shorelines and abundant feed. The numbers of nesting geese have tended to increase since a low point in the mid-1970's, but the nesting sites have shifted mainly to the islands downstream of Ringold as a result of coyote predation (Jaquish and Bryce 1990).

Migrant geese also use the Hanford Reach as a rest area in the fall and winter. Hundreds to thousands of these geese use the open fields in the 100 Areas for foraging on the islands and the river for resting.

Mallard ducks also nest on the Hanford Reach, using clumps of dense vegetation near water for nest sites. Patches of currant, willow, lupine, absinthe, horsetail, ryegrass, and Russian thistle provide for most of the nesting sites. About 100,000 waterfowl of many species use this section of the river during migration and winter (Fickeisen et al. 1980a). Ducks eat aquatic plants and insects and will also forage in agricultural fields.

Colonies of California and ring-billed gulls and Forster's terns use islands on the Hanford Reach for nesting. However, they have abandoned the islands near the old production reactors in favor of islands near Richland due to coyote predation (Fickeisen et al. 1980a, Rickard et al. 1982). Gulls and terns are omnivorous.

Great blue herons nest in the trees along the Columbia River in the 100 Areas, at the White Bluffs sloughs and F Area. Nesting colonies are relatively scarce because of the lack of suitable nesting trees (Rickard et al. 1978, 1982). Herons will feed on insects and amphibians but utilize fish such as carp and suckers during the nesting season (Rickard et al. 1982). While the free-flowing Hanford Reach is important to

Table 2. Birds Observed at 100 Areas Operable Units (from Sackschewsky and Landeen 1992). (sheet 1 of 4)

Family	Common name	Genus species	Status
Gaviidae	common loon	*Gavia immer*	Rw
Podicipedidae	pied-billed grebe*	*Podilymbus podiceps*	Cr
	horned grebe	*Podiceps auritus*	Uw
	western grebe	*Aechmophorus occidentalis*	Ur
Pelecanidae	American white pelican	*Erythrorhynchos pelecanus*	Cr
Phalacrocoracidae	double-crested cormorant	*Phalacrocorax auritus*	Rr
Ardeidae	great blue heron*	*Ardea herodias*	Cr
	black-crowned night-heron	*Nycticorax nycticorax*	Cr
Anatidae	Canada goose*	*Branta canadensis*	Cr
	mallard	*Anas platyrhynchos*	Cr
	northern pintail	*Anas acuta*	Cw
	blue-winged teal	*Anas discors*	Us
	cinnamon teal	*Anas cyanoptera*	Us
	northern shoveler	*Anas clypeata*	Cw
	gadwall	*Anas strepera*	Cw
	American widgeon	*Anas americana*	Cw
	redhead	*Aythya americana*	Cw
	ring-necked duck	*Aythya collaris*	Uw
	lesser scaup	*Aythya affinis*	Uw
	greater scaup	*Aythya marila*	Rw
	common goldeneye	*Bucephala clangula*	Uw
	bufflehead	*Bucephala albeola*	Cw
	common merganser	*Mergus merganser*	Cw
	ruddy duck	*Oxyura jamaicensis*	Uw
Accipitridae	osprey	*Pandion haliaeetus*	Um
	bald eagle	*Haliaeetus leucocephalus*	Cw
	northern harrier*	*Circus cyaneus*	Cr
	Swainson's hawk	*Buteo swainsoni*	Us
	red-tailed hawk	*Buteo jamaicensis*	Cr
	ferruginous hawk	*Buteo regalis*	Rs
	rough-legged hawk	*Buteo lagopus*	Rw
	golden eagle	*Aquila chrysaetos*	Ur
Falconidae	American kestrel*	*Falco sparverius*	Cr
	merlin	*Falco columbarius*	Rr
	prairie falcon	*Falco mexicanus*	Ur

Table 2. Birds Observed at 100 Areas Operable Units (from Sackschewsky and Landeen 1992). (sheet 2 of 4)

Family	Common name	Genus species	Status
Phasianidae	gray partridge	*Perdix perdix*	Ur
	chukar	*Alectoris chukar*	Ur
	ring-necked pheasant*	*Phasianus colchicus*	Ur
	California quail*	*Callipepla californica*	Ur
Rallidae	American coot*	*Fulica americana*	Cr
Gruidae	sandhill crane	*Grus canadensis*	Um
Charadriidae	killdeer*	*Charadrius vociferus*	Cr
Scolopacidae	greater yellowlegs	*Tringa melanoleuca*	Um
	long-billed curlew	*Numenius americanus*	Cs
	common snipe	*Gallinago gallinago*	Ur
Laridae	ring-billed gull	*Larus delawarensis*	Cr
	California gull	*Larus californicus*	Cr
	caspian tern	*Sterna caspia*	Us
	Forster's tern	*Sterna forsteri*	Cs
Columbidae	rock dove*	*Columba livia*	Cr
	mourning dove*	*Zenaida macroura*	Cr
Tytonidae	common barn-owl	*Tyto alba*	Ur
Strigidae	great horned owl	*Bubo virginianus*	Ur
	long-eared owl*	*Asio otus*	Ur
Caprimulgidae	common nighthawk	*Chordeiles minor*	Cs
Trochilidae	calliope hummingbird	*Stellula calliope*	Um
Alcedinidae	belted kingfisher	*Ceryle alcyon*	Ur
Picidae	northern flicker	*Colaptes auratus*	Cr
Tyrannidae	western wood-pewee	*Contopus sordidulus*	Um
	willow flycatcher	*Empidonax traillii*	Rm
	Say's phoebe	*Sayornis saya*	Us
	western kingbird*	*Tyrannus verticalis*	Cs
	eastern kingbird*	*Tyrannus tyrannus*	Us
Alaudidae	horned lark*	*Eremophila alpestris*	Cr
Hirundinidae	northern rough-winged swallow	*Stelgidopteryx serripennis*	Us
	bank swallow	*Riparia riparia*	Us
	cliff swallow*	*Hirundo pyrrhonota*	Cs
	barn swallow*	*Hirundo rustica*	Cs

Table 2. Birds Observed at 100 Areas Operable Units
(from Sackschewsky and Landeen 1992). (sheet 3 of 4)

Family	Common name	Genus species	Status
Corvidae	black-billed magpie*	*Pica pica*	Cr
	common raven*	*Corvus corax*	Cr
	Clark's nutcracker	*Nucifraga columbiana*	Am
Paridae	black-capped chickadee	*Parus atricapillus*	Ur
Troglodytidae	marsh wren*	*Cistothorus palustris*	Ur
Muscicapidae	ruby-crowned kinglet	*Regulus calendula*	Uw
	American robin*	*Turdus migratorius*	Cr
	varied thrush	*Ixoreus naevius*	Uw
Bombycillidae	cedar waxwing	*Bombycilla cedrorum*	Ur
Laniidae	northern shrike	*Lanius excubitor*	Uw
	loggerhead shrike*	*Lanius ludovicianus*	Us
Sturnidae	European starling*	*Sturnus vulgaris*	Cr
Vireonidae	solitary vireo	*Vireo solitarius*	Um
	warbling vireo	*Vireo gilvus*	Um
Emberizidae	yellow warbler	*Dendroica petechia*	Us
	yellow-rumped warbler	*Dendroica coronata*	Cw
	Townsend's warbler	*Dendroica townsendi*	Um
	Wilson's warbler	*Wilsonia pusilla*	Um
	western tanager	*Piranga ludoviciana*	Um
	black-headed grosbeak	*Pheucticus melanocephalus*	Us
	vesper sparrow	*Pooecetes gramineus*	Rm
	lark sparrow	*Chondestes grammacus*	Rs
	sage sparrow	*Amphispiza belli*	Us
	savannah sparrow*	*Passerculus sandwichensis*	Us
	song sparrow	*Melospiza melodia*	Cr
	white-crowned sparrow	*Zonotrichia leucophrys*	Cr
	dark-eyed junco	*Junco hyemalis*	Cw
	red-winged blackbird*	*Agelaius phoeniceus*	Cr
	western meadowlark*	*Sturnella neglecta*	Cr
	yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Cs
	Brewer's blackbird*	*Euphagus cyanocephalus*	Cr
	brown-headed cowbird	*Molothrus ater*	Cr
	northern oriole	*Icterus galbula*	Cs

Table 2. Birds Observed at 100 Areas Operable Units (from Sackschewsky and Landeen 1992). (sheet 4 of 4)

Family	Common name	Genus species	Status
Fringillidae	house finch	*Carpodacus mexicanus*	Cr
Passeridae	house sparrow	*Passer domesticus*	Cr

A status rating is given for abundance and seasonal occurrence for each species as follows:

Abundance:

C = common; often seen or heard in appropriate habitat.
U = uncommon; usually present but not always seen or heard.
R = rare; present in appropriate habitats only in small numbers, seldom seen or heard.
A = accidental; appeared once or twice, but well out of normal range.

Seasonal occurrence:

r = resident; present all year but abundance may vary seasonally.
s = summer visitor (includes spring and fall).
w = winter visitor (includes spring and fall).
m = migrant.

*Species that were observed in breeding and nesting activities.

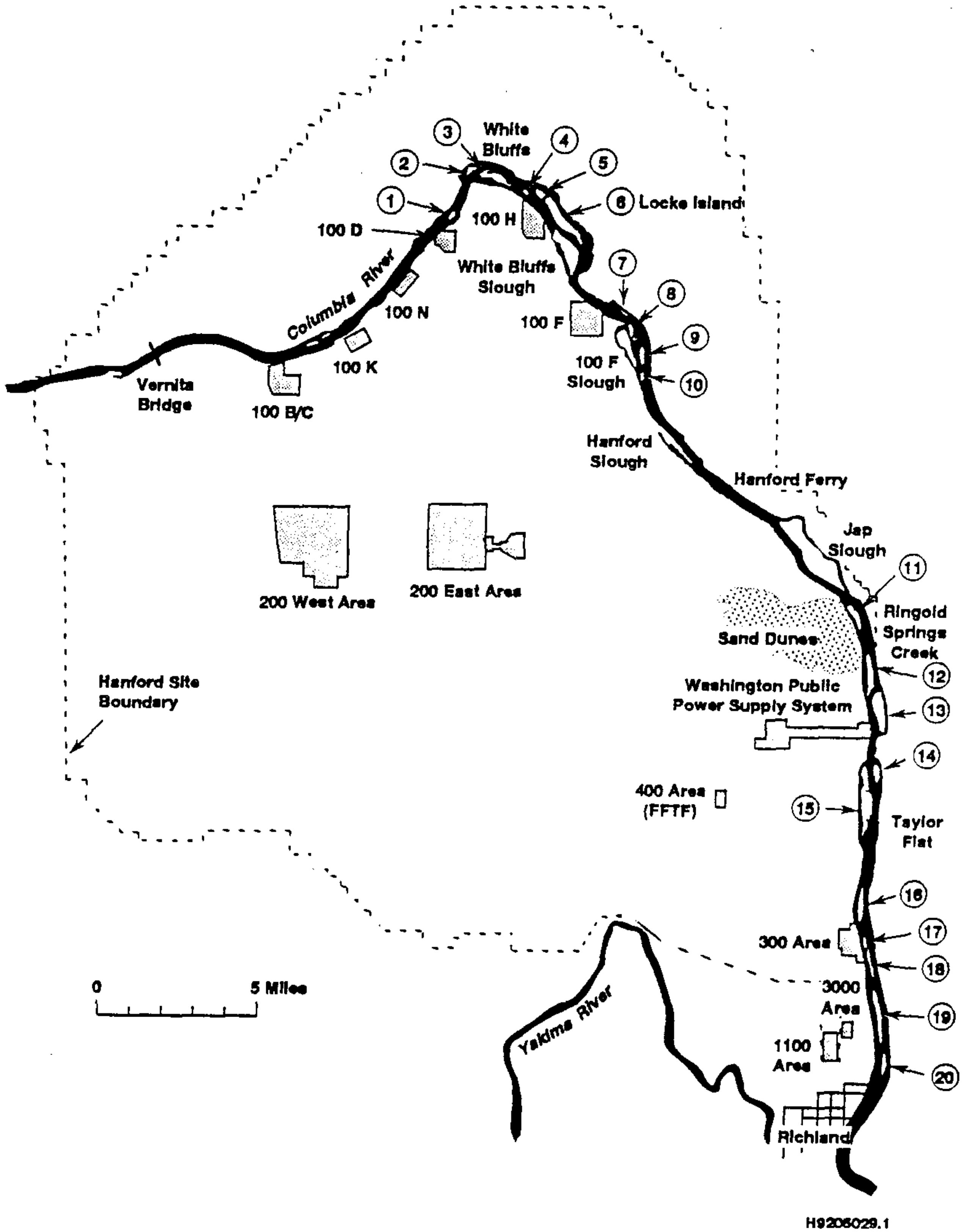

Figure 4. Islands of the Columbia River Within the Hanford Reach (from Sackschewsky et al. 1992).

feeding herons during severe winter weather (Fickeisen et al. 1980a), they also feed in slower moving water, such as the sloughs, and can feed several miles from the nest site.

White pelicans historically used the Hanford Reach as a foraging stop during migration (Fickeisen et al. 1980a). In recent years the size of the flock and length of time spent on the Hanford Reach has increased. In 1989, drought drove about 1,500 white pelicans from their nesting area in Nevada to the Columbia Basin to find food (WDOW 1989). About 100 white pelicans spend the summer and fall on the Columbia River, from the Hanford Reach to near the confluence of the Walla Walla River. White pelicans eat fish.

Large numbers of swallows also depend on the Columbia River riparian areas, eating flying aquatic insects such as caddis flies emerging from the riffle substrates of the river (Rickard et al. 1982). Most swallow species also collect mud from riparian and other wetted areas for building nests.

3.2.4 Reptiles and Amphibians

Twelve species (Cushing 1991) of amphibians and reptiles have been observed at the Hanford Site (Table B-4). The side-blotched lizard is the most abundant reptile and can be found throughout the Hanford Site. Short-horned and sagebrush lizards are also found in selected habitats. The most common snakes are the gopher snake, the yellow-bellied racer, and the Pacific rattlesnake, which are found throughout the Hanford Site. Striped whipsnakes and desert night snakes are rarely found. Toads and frogs are found near ephemeral and permanent water bodies and along the Columbia River. Because of their low numbers and because they are not in a direct pathway to humans, they are not considered further here.

3.2.5 Insects

More than 300 species of terrestrial and aquatic insects have been collected on the Hanford Site (Table B-5).

Grasshoppers and darkling beetles are among the more conspicuous insect groups and are important in the food web of the local birds and mammals (Figures 5 and 6). Most species of darkling beetles occur at various times throughout the spring-to-fall period, although some species are present only during 2 or 3 months in the fall (Rogers and Rickard 1977). Darkling beetles are scavengers, eating decaying vegetation, animal excrement, fungi, and living plants (Rogers et al. 1978). Darkling beetles eat a wide variety of plants, with tansy mustard the most preferred (15% consumption frequency), followed by big sagebrush and cryptogams (13% each) and cheatgrass (9%). Rickard and Rogers (1983) identified these beetles as probably more abundant in terms of biomass than birds and mammals, with their biomass reaching 20 kg/ha. Grasshoppers are common during the late spring to fall. Both groups are subject to wide annual and seasonal variations in abundance.

Harvester ants have been implicated in the transport of buried contaminants to the surface (Watson et al. 1984). Klepper et al. (1979) quantified the size, depth, and amount of soil excavated by harvester ant

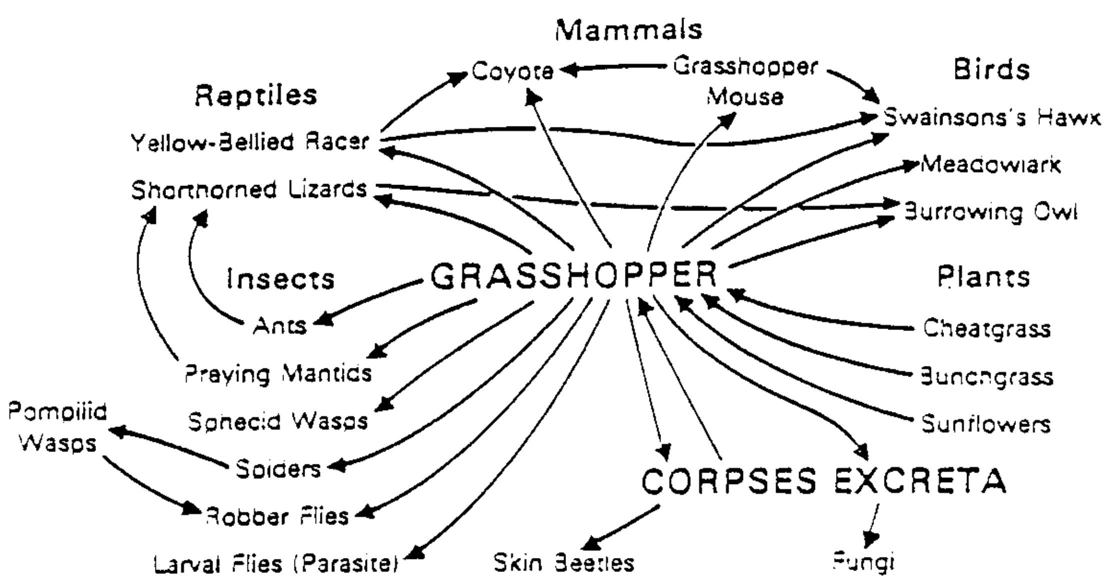

Figure 5. Food Web Centered on Grasshoppers (arrows indicate direction of energy and mass transfer) (from Watson et al. 1984).

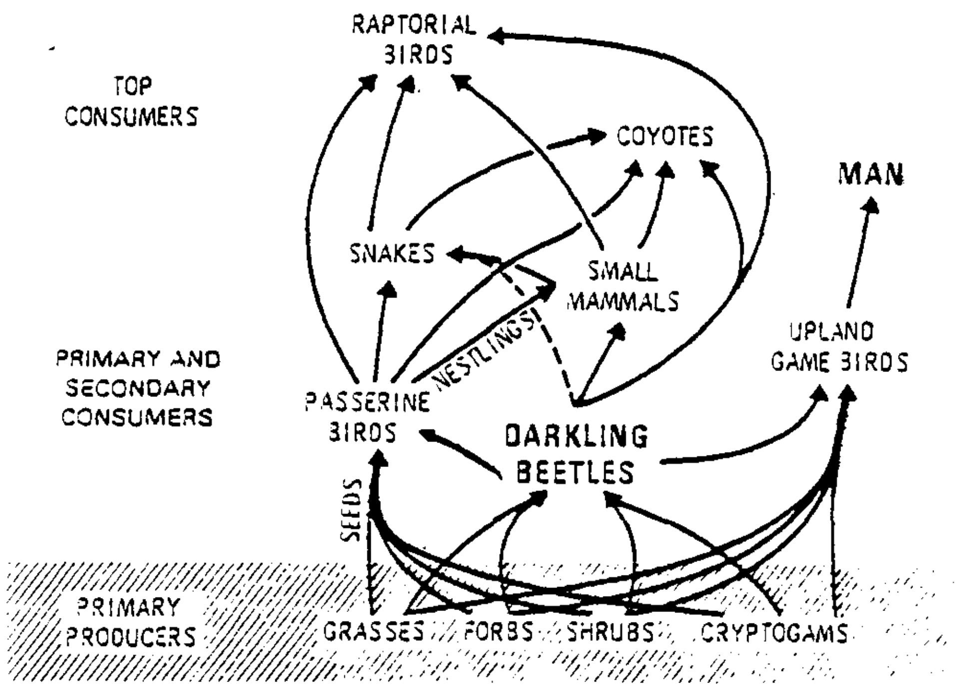

Figure 6. Food Web Showing Relationship of Darkling Beetles to Transfer Pathways (from Rogers et al. 1984).

colonies in the 200 Areas (Table 3). Similar excavations could occur in the 100 Areas. Rogers and Rickard (1977) reported an average of 39 harvester ant colonies per hectare in 5 300 Area fenced burial sites versus 10 per hectare in 5 control sites.

Although honeybees were not identified in ERDA's (1975) list of Hanford Site insects, they are a potential resident or visitor to the Site, especially from domestic hives that may be set out along the Columbia River or from swarms that have become feral. Honeybees have been used successfully as monitors of radionuclide contamination on the Hanford Site (Simmons et al. 1990).

Table 3. Harvester Ant (*Pogonomyrmex owyheei*) Nest Characteristics (from Klepper et al. 1979).

Depth	Ant numbers	Chamber numbers	Soil volume excavated[a]	
			Per nest (in.^{3})	Entire crib[b] (in.^{3})
Mound	814	[c]	--	--
Top 1 ft	350	[c]	--	--
1-2 ft	293	26	11.1	1,154
2-3 ft	217	13	9.2	957
3-4 ft	441	10	7.5	780
4-6 ft	225	10	5.4	562
6-8 ft	1,835	9	9.1	946
TOTALS	4,175	68	42.3	4,399

[a]Volume of soil excavated was calculated by summation of volume calculations for chambers and tunnels. Nest excavation was conducted on May 15, 1975, near 216-A-24 Crib.

[b]Soil volume excavated for the entire crib area was calculated by multiplying soil volume excavated per nest times 104 nests in the study area.

[c]The mound and upper foot of the nest was composed of numerous interconnecting chambers that were not counted.

4.0 FOOD WEBS

The dynamic interplay of numerous organisms can best be illustrated through the use of food webs indicating the routes of energy transfers between species. However, food webs do not quantify the rates of energy flows from organism to organism, which can vary yearly, seasonally, spatially, from species to species, and individually. The following represent a few basic ecological associations for the Hanford Site, with emphasis on important transfer pathways to humans.

4.1 COLUMBIA RIVER BIOTA

Hanford Reach fish do not appear selective in the species of insects they eat. Stomach content analyses of Hanford Reach fish from 1973 to 1980 showed benthic invertebrates to be important food items for almost all juvenile and adult fish (Cushing 1991). Dauble et al. (1980) also found correlations with adult insect abundance and trends in benthic prey density with the diet of juvenile chinook salmon. Midge-fly larvae and pupae accounted for 78% by number and 59% by volume of total ingested items in 0-age chinook salmon during March to June; caddis fly adults and Daphnia were important in June and July.

Adult salmon do not feed during their spawning runs up the river (Cushing 1991, Watson et al. 1984). Consequently, although salmon are the dominant fish harvested from the Hanford Reach, they are not expected to ingest any contamination from other biota in the Columbia River and do not act as a pathway to humans or the environment. However, environmental monitoring data in the 1960's (e.g., Foster 1966) showed measurable levels of radionuclides in some salmon and steelhead from Priest Rapids to Richland. One of eleven steelhead had 0.4 pCi/g ^{60}Co; eight of eleven had measurable ^{137}Cs (maximum of 0.6 pCi/g). One of two salmon had measurable ^{137}Cs (0.6 pCi/g); neither had measurable ^{60}Co (Foster 1966).

Figure 7 is a simplified diagram of food web relationships in the Columbia River ecosystem, representing probable major energy (and thus contaminant) pathways. Note that this food web does not show the relative magnitude of energy transfer from one level to the next. Waterfowl and swallows are addressed in the Terrestrial section.

4.2 TERRESTRIAL BIOTA

Figure 8 summarizes the energy transfer pathways for a cheatgrass community, which is the dominant vegetation type on most of the disturbed sites within the 100 Areas. Although inadvertently introduced to this region, this grass is well adapted to the Hanford climate. Its success does not stem from a highly efficient capture of energy from the sun, but from physiological adaptation. It is geared for growth under the cool conditions concurrent with the Hanford Site's wet season. Consequently, green cheatgrass appears (as seedlings) when few perennials are growing. It tends to deplete the soil moisture, hindering the growth of later growers. When it is green and the seeds are soft, cheatgrass is forage for a variety of animals, including mule deer, coyotes, and chukars. Mature cheatgrass seeds are an important food source for pocket mice and birds but are avoided by deer and rabbits (and domestic livestock off the Hanford Site). The dead leaves and stems support a large number of microbiota, including mites, insects, nematodes, and fungi (ERDA 1975).

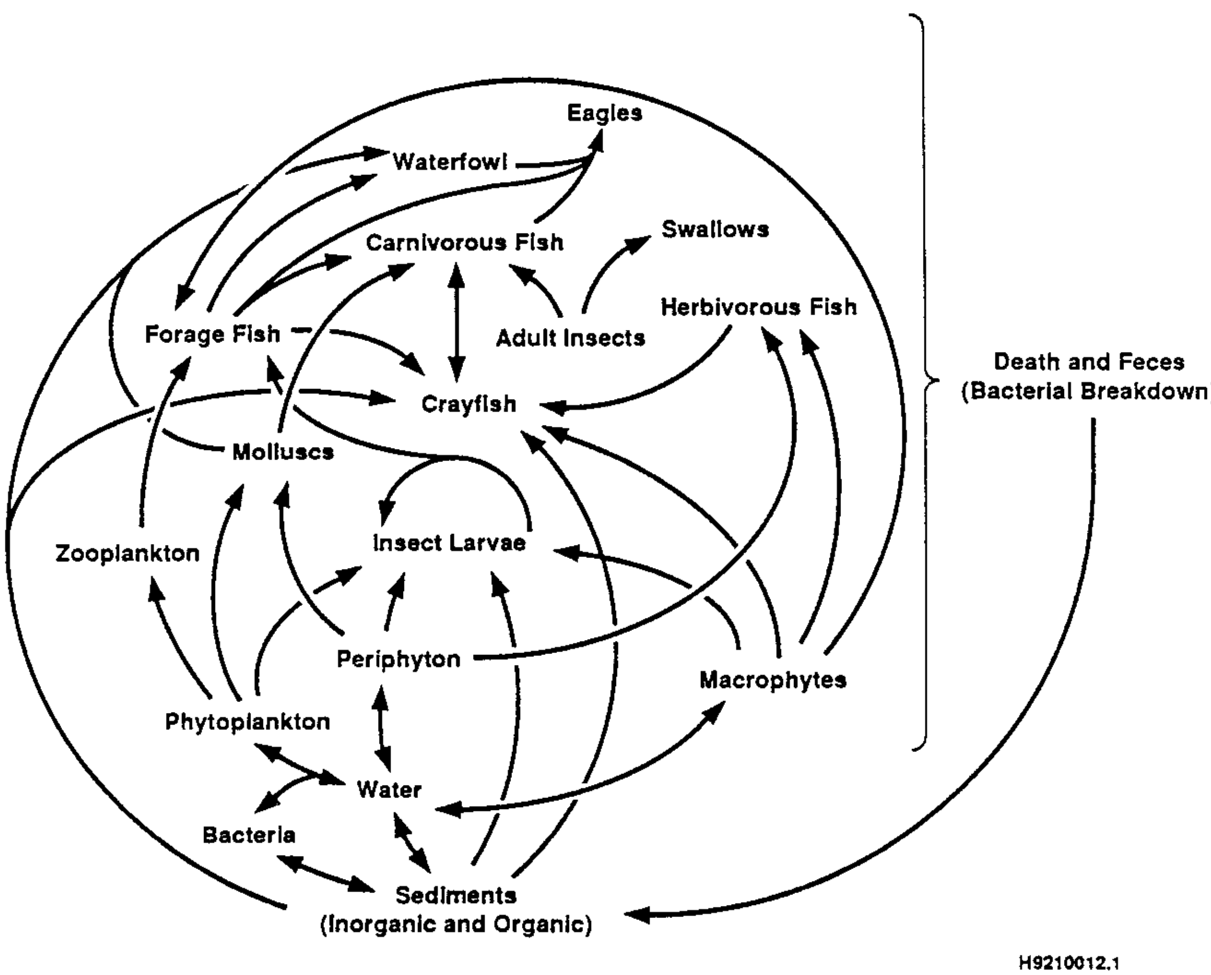

Figure 7. Food Web in the Columbia River (from Cushing 1991).

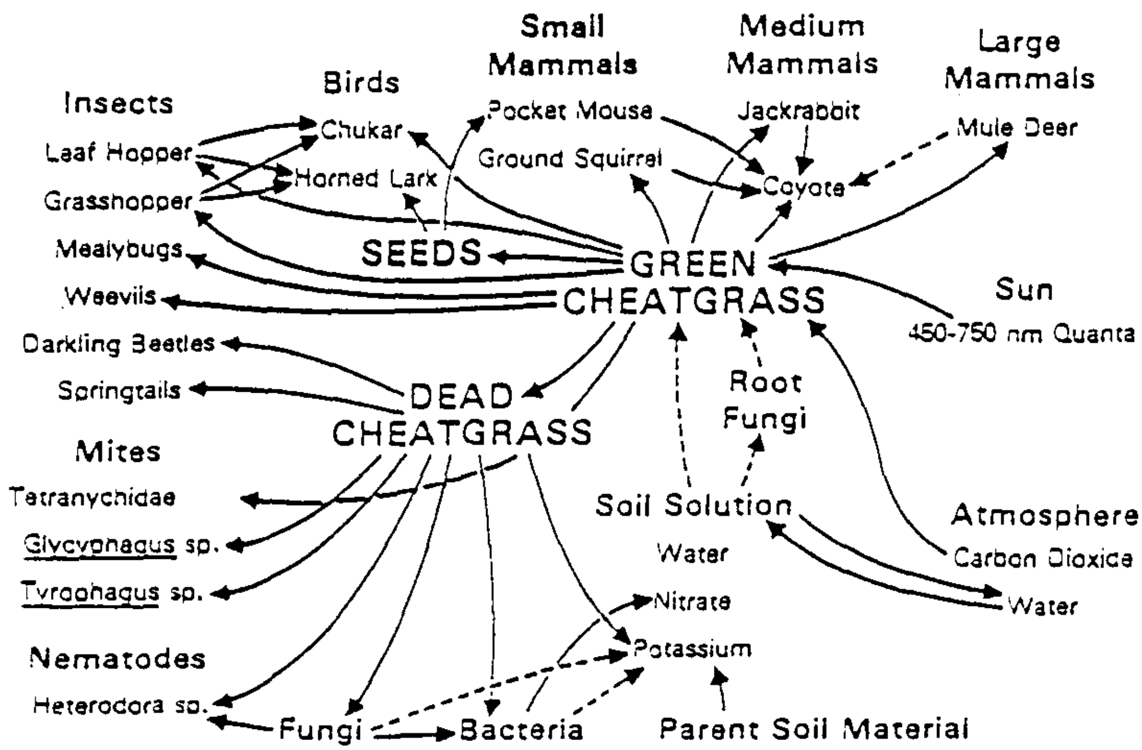

Figure 8. Food Web Centered on a Cheatgrass Community (arrows indicate direction of energy and mass transfer) (from Cushing 1991).

Riparian vegetation is also important, but no food web examples were found in the Hanford Site-related literature. However, in a very simplified narrative, this vegetation uptakes soil nutrients and contaminants as well as a combination of groundwater and river water stored in the riverbank and shallow sediments and absorbs material deposited aerially. The vegetation is then eaten by passerine birds (especially the fruit), game birds, insects, deer, mice, rabbits (especially the green leaves), and beavers (especially the woody stems). These animals are in turn fed on by coyotes, hawks, and humans. Fish (e.g., carp and sturgeon) and aquatic insects may consume dead organic material fallen from the riparian zone; fish are eaten by humans, other fish, and birds (e.g., pelicans).

A food web centered on grasshoppers is shown in Figure 5. A food web for darkling beetles is illustrated in Figure 6.

Larger food items support larger consumers; Figure 9 centers on the chukar, a bird with an average adult biomass of somewhat less than a kilogram. The chukar, in common with the ring-necked pheasant, is opportunistic in its choice of diet, eating both plant and animal matter in their periods of seasonal abundance. Chukars support avian predators such as hawks and scavengers such as magpies. Mammalian and reptilian predators take advantage of brooding chukar hens and eggs. Chukars, gray partridges, pheasant, quail, and mourning doves are harvested by hunters off the Hanford Site. Thus, Hanford Site birds could be shot and consumed by hunters off the Site.

Duck and goose hunting is a popular sport in Benton and Franklin Counties. Thus, waterfowl are also an element in the food chains leading to humans. Within the 100 Areas, a few species of ducks (mostly mallards) nest along the Columbia River. Most of the waterfowl use is during the fall migration period. Hunters are not permitted on the Hanford Site on the facility side of the river, so this area is a refuge for ducks and geese during the hunting season. Many geese nest along the Columbia River; these birds and their young graze on reed canary grass growing along the shoreline. Rickard and Price (1990) indicated a relationship between increased levels of ^{90}Sr in goose eggs from an island downstream of the N Reactor and levels in reed canary grass from immediately downstream of the N Reactor (see Chapter 5.0, "Known Contamination"). Strontium is a calcium analog and is expected to be concentrated in eggshells and bones more than muscle tissue.

5.0 KNOWN CONTAMINATION

5.1 COLUMBIA RIVER BIOTA

5.1.1 Water and Sediment Contamination

For the year 1989, the reported radionuclides, in total curies for all year, in liquid effluents discharged to the Columbia River from the 100 Areas were tritium, 74; ^{60}Co, 0.078; ^{90}Sr, 1.7; ^{137}Cs, 0.073;

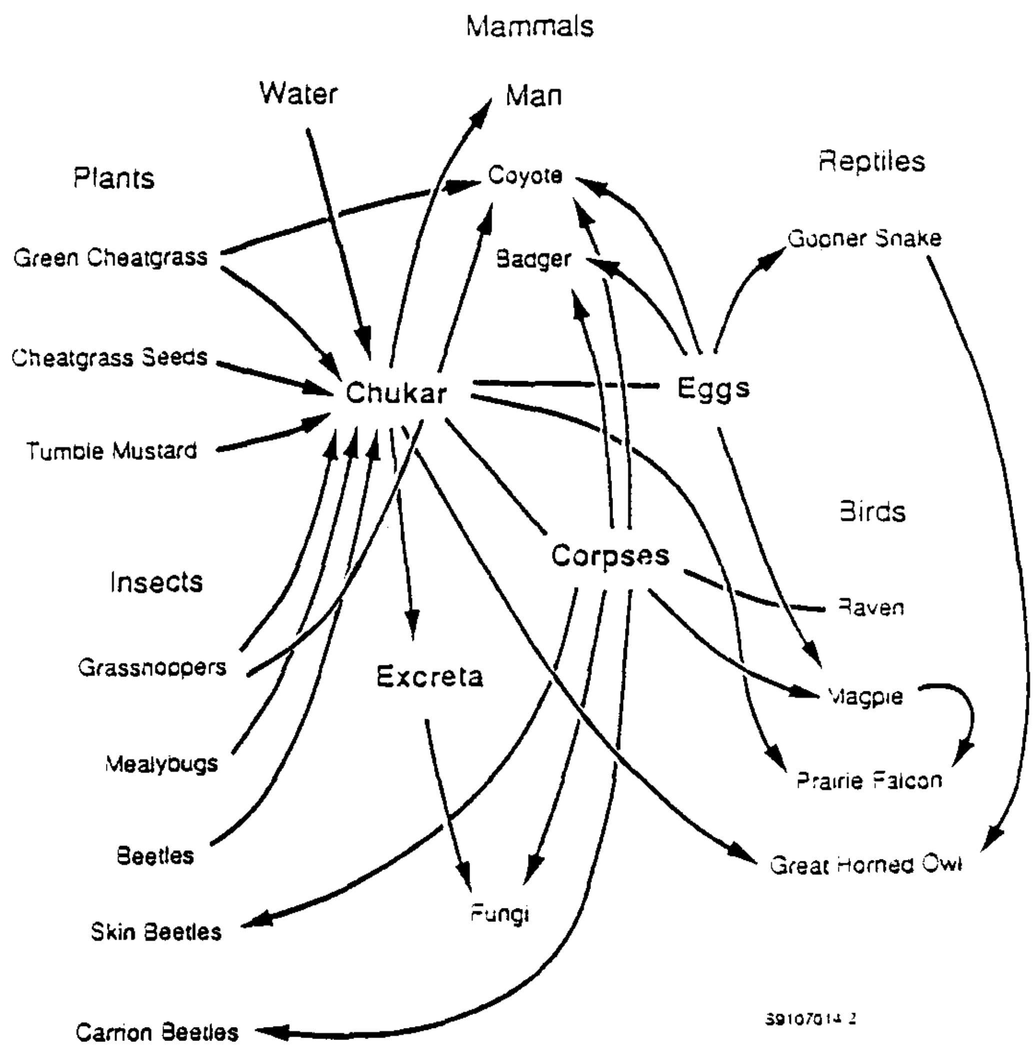

Figure 9. Food Web Centered on Chukar (arrows indicate direction of energy and mass transfer) (from Cushing 1991).

and ^{239}Pu, ^{240}Pu, 0.000084 (Jaquish and Bryce 1990). For 1990, the releases (in curies) were tritium, 38; ^{60}Co, 0.04; ^{90}Sr, 1.9; ^{137}Cs, 0.02; and ^{139}Pu, ^{140}Pu, 0.0000021 (Woodruff et al. 1991).

The seepages at the 100-N Area are monitored annually for radioactivity (Perkins 1988, 1989). Total radionuclide concentrations were 35% lower in 1988 compared to 1987; ^{103}Ru, ^{106}Ru, and ^{131}Ru decreased to less than detectable levels in all locations. Tritium concentrations varied to above 100,000 pCi/L.

However, the net increase in ^{90}Sr concentrations was 23% from 1987 to 1988. The levels of ^{90}Sr tended to be higher in 100-N Area upstream seeps (Perkins 1989). Rokkan (1990) states that ^{90}Sr is the most significant radionuclide released from the 100 Areas, but determined that the average concentration of ^{90}Sr released from the N Springs decreased by 15% from 1988 to 1989. He reported a total strontium release of 1.8 Ci in 1989, with an average concentration of 5.9×10^{-6} μCi/mL.

The total offsite maximally exposed individual (MEI) dose for 1989 from all Hanford Site releases was 0.05 mrem, down from 0.08 mrem for 1988 (Jaquish and Bryce 1990). Of the 0.05 mrem dose for 1989, 20% came from the 1.8 Ci of ^{90}Sr released from the N Springs (Rokkan 1990). In 1990, the MEI dose computed to 0.03 mrem (Woodruff et al. 1991). The decrease was primarily due to the absence of ^{99}Tc in river water in 1990. However, 28% of the dose was credited to consumption of fish from the Columbia River (0.008 mrem). The dose limit for any member of the public from all routine U.S. Department of Energy (DOE) operations is 100 mrem/yr. Thus, the estimated dose for the 1990 MEI was 0.03% of the DOE limit (Woodruff et al. 1991).

In 1988, Dirkes (1990) conducted a study on riverbank springs. All samples were analyzed for gross alpha, gross beta, gamma scan, tritium, and nitrate; selected samples were also analyzed for additional radionuclides and other constituents such as ICP metals, arsenic, mercury, lead, enhanced pesticides and herbicides, and volatile organic compounds (VOC). Columbia River water at the Priest Rapids Dam and Richland pumphouse was also analyzed for radionuclides and chemical constituents. Nonradiological contaminants were generally undetectable in spring water; ^{90}Sr was at 7,270 ± 192 pCi/L at the 100-N Area; tritium was 75,800 ± 908 pCi/L at the same location and on the same day.

Twenty-six spring locations were sampled in 1991, from the 100-B Area to the Hanford Townsite (DOE 1992). In brief, contaminants enter the river to some degree at each reactor area. The contaminants primarily are tritium, ^{90}Sr, Cr, and nitrate. The maximum tritium concentrations observed were 24,000 pCi/L at 100-N; ^{90}Sr also peaked at 100-N at 3,210 pCi/L. Chromium (assumed to be chromium VI) was highest along the 100-D Area at 124 ppb. The highest level of ^{99}Tc was 12 pCi/L near the 100-H Area.

Jaquish and Bryce (1990) also analyzed water samples for radionuclides in the Columbia River at Priest Rapids Dam, the 300 Area, and the Richland pumphouse in 1989. Levels were extremely low, being essentially undetectable with the use of special sampling techniques and analytical procedures. The average gross alpha and beta concentrations were 15 and 50 pCi/L, respectively. Woodruff et al. (1991) reported tritium concentrations at

Priest Rapids Dam and Richland pumphouse below the 3000 Area, (see Figure 1) during 1990 as 52 pCi/L ± 6% and 104 pCi/L ± 18%, respectively, similar to 1989. Average annual ^{90}Sr concentrations at Priest Rapids Dam and Richland during 1990 were 0.07 pCi/L ± 29% and 0.08 pCi/L ± 25%, respectively.

Jaquish and Bryce (1990) also studied the levels of radionuclides in sediments at White Bluffs, 100-F Area, and Hanford Townsite sloughs, and from behind Priest Rapids Dam, at the city of Richland, and behind McNary Dam. McNary sediments tended to be higher than levels behind Priest Rapids Dam and in the Hanford Site sloughs. The sloughs with the maximum concentration for a particular radionuclide were (in picocuries per gram dry weight): ^{60}Co, 0.055 ± 0.020 (100-F slough); ^{90}Sr, 0.021 ± 0.006 (Hanford slough); ^{137}Cs, 0.284 ± 0.032 (White Bluffs slough); and ^{106}Ru, 0.210 ± 0.146 (100-F slough). These same radionuclides in the sediment behind Priest Rapids Dam were (maximum concentrations) ^{60}Co, 0.011 ± 0.018; ^{90}Sr, 0.016 ± 0.005; ^{137}Cs, 0.298 ± 0.032; and ^{106}Ru, 0.043 ± 0.136.

5.1.2 Groundwater Monitoring for Other Contaminants

While ^{99}Tc is a highly mobile radionuclide, information regarding the levels of ^{99}Tc is somewhat limited for groundwater on the Hanford Site. Groundwater monitoring (Evans et al. 1990) continued to analyze for ^{99}Tc in 1989 and found concentrations in wells in the 100-H Area to be a maximum of 3,650 pCi/L on May 25, 1989, near the 183-H Solar Evaporation Basins in well 199-H4-3.

A uranium plume was identified in the 100-H Area, again near the 183-H Solar Evaporation Basins. The maximum concentration during 1989 was 89 pCi/L in well 199-H4-4 (Evans et al. 1989).

Evans et al. (1990) also reported hexavalent chromium in wells from the 100-B, D, F, H, and K Areas, with the highest concentrations in well 199-D5-12 (just east of the 100-D Reactor) at 692 µg/L, down more than a factor of two from 1987 measurements. The plume of chromium extended west to the river but declined to levels estimated to be less than 200 µg/L along the shore. Well 199-H4-3, next to the 183-H Basins, showed a peak concentration for the 100-H Area of 208 µg/L, with less than 150 µg/L estimated nearer the shore.

5.1.3 Radioactive Contamination in Aquatic Biota

Most of the earlier studies of radionuclide concentrations in Columbia River biota emphasized the short-lived ^{32}P (half-life of 14.3 days) and ^{65}Zn (half-life of 245 days) because of their high levels in the releases and in the biota relative to most other radionuclides. For example, Davis (1962) examined the radionuclide content of caddis fly larvae (Hydropsyche cockerelli) from the Columbia River when the reactors were running. In February, selected levels of radionuclides were 4,200 pCi/g of ^{32}P, 730 pCi/g of ^{65}Zn, and 30 pCi/g of ^{60}Co. In August the levels changed to 24,000 pCi/g of ^{32}P, 2,000 pCi/g of ^{65}Zn, and 2 pCi/g of ^{60}Co. The levels of radiocesium and strontium were not given. Because the levels of the much-studied but short-lived radionuclides have essentially been reduced to zero through decay and cessation of releases, they are not emphasized in this report.

Cushing et al. (1981) determined the decline in concentration of radionuclides in Columbia River ecosystem biota after shutdown of the Hanford Site reactors with once-through cooling systems (N Reactor was still operating). They studied the levels of radionuclides in plankton, periphyton, and invertebrates (caddis fly larvae) from July 1971 through June 1972 in three river locations: White Bluffs (north of the 100-F Area), above McNary Dam, and above Bonneville Dam. Cobalt-60 (half-life of 5.24 years) and ^{65}Zn were emphasized because they were present in biota in quantities large enough to detect. Decreasing concentrations of radionuclides were a result of three processes: physical decay, biological turnover, and decreasing radionuclide availability. While concentrations of ^{60}Co did not decrease to the same degree as other radionuclides, the data in Cushing et al. (1981) showed that the measurable concentrations of radionuclides in aquatic biota decreased to extremely low or unmeasurable levels within 18 to 24 months after cessation of discharge of reactor once-through cooling water. The levels of ^{60}Co in suckers from White Bluffs averaged 0.68 pCi/g (m = 13). Cobalt-60 was still seeping into the river from a disposal trench near the operating N Reactor during their study, affecting the concentrations of that radionuclide in biota. Cobalt-60 concentrations in periphyton at White Bluffs decreased from 22 to 2 pCi/g dry weight (DW) during the first year (1971) of the study, above McNary Dam the concentrations decreased from 34 to about 3 pCi/g DW during the same time. Caddis fly larvae at White Bluffs showed no appreciable decline of ^{60}Co; the mean concentration was 12.0 ± 2.5 pCi/g DW.

Dauble et al. (1992) examined radionuclides in sturgeon from four locations along the Columbia during 1989 and 1990: the Hanford Reach (including McNary pool), Lake Roosevelt (above Grand Coulee Dam), between Astoria and Bonneville Dam, and below the Dalles Dam. Sturgeon were chosen for the study because they are long-lived, bottom feeders, omnivorous, an important sport species, and do not move through the Columbia River dams. For these reasons, they should be an excellent indicator of persistent contamination in aquatic biota (Dauble et al. 1988). Radionuclide analysis included ^{40}K, ^{60}Co, ^{65}Zn, and ^{137}Cs for muscle, ^{238}Pu, ^{239}Pu, and ^{240}Pu for liver, and ^{90}Sr for cartilage. Maximum concentrations for any measured industrial radionuclide were less than 0.01 pCi/g. The potential dose to a person who consumed any of the sturgeon was less than 0.01 mrem (Dauble et al. 1992).

Eberhardt et al. (1989b) studied the 1971 through 1988 trends in radionuclide concentrations in wildlife from the Hanford Site (including the Hanford Reach). No upward trends were detected; many samples showed a significant downward trend, particularly for ^{137}Cs. Three factors contributed to this decrease: cessation of nuclear weapon atmospheric testing; the 1971 shutdown of the last once-through cooling-water design production reactor; and the reduction of environmental contamination associated with some Hanford Site facilities and operations. Table 4 lists the 12 fish species sampled from 1971 to 1988 (as well as other wildlife). Concentrations of ^{60}Co in mountain whitefish steadily declined from a high of 0.3 pCi/g in 1971 to near zero after 1978. Concentrations of ^{65}Zn also declined, but more rapidly than ^{60}Co. See Figures 10 and 11.

Further studies during 1989 in the ongoing Hanford Environmental Monitoring Program (Jaquish and Bryce 1990) on whitefish (from the 100-D Area and Priest Rapids Dam), bass (from the 100-F Area), and salmon (from the 100-H Area) for levels of ^{60}Co, ^{90}Sr, and ^{137}Cs in fillets and ^{90}Sr in bone.

Table 4. Wildlife Samples Collected by the Pacific Northwest Laboratory Environmental Monitoring Program on the Hanford Site from 1971 through 1988 (from Eberhardt et al. 1989b). (sheet 1 of 2)

Sample type	Year																	
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Bass (Micropterus spp.)		x					x	x		x	x	x	x	x	x	x	x	x
Bluegill (Lepomis spp.)		x																
Carp (Cyprinus carpio)							x	x										
Catfish (Ictalurus spp.)		x				x					x							
Crappie (Pomoxis spp.)	x																	
Perch (Perca spp.)	x																	
Chinook salmon (Oncorhynchus tschawytscha)						x		x										
Northern squawfish (Ptychocheilus oregonensis)						x	x	x										
Steelhead (Salmo gairdneri)		x					x	x										
White sturgeon (Acipenser transmontanus)		x					x	x										
Sucker (Catostomus spp.)						x	x	x										
Mountain whitefish	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Coyote (Canis latrans)		x						x										
Mule deer (Odocoileus hemionus)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mice	x	x	x	x	x	x	x	x										
Rabbits/hares	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Raccoon (Procyon lotor)			x															
Chukar* (Alectoris chukar)							x				x	x	x	x				
Ring-necked pheasant* (Phasianis colchicus)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
California quail* (Callipepla californica)							x	x	x	x	x	x						

Table 4. Wildlife Samples Collected by the Pacific Northwest Laboratory Environmental Monitoring Program on the Hanford Site from 1971 through 1988 (from Eberhardt et al. 1989b). (sheet 2 of 2)

Sample type	Year																	
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Mourning dove (Zenaida macroura)											x							
Gray partridge (Perdix perdix)											x							
Waterfowl	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

*Chukar, ring-necked pheasant, and California quail were combined into a single category, upland game birds, in the database after 1982.

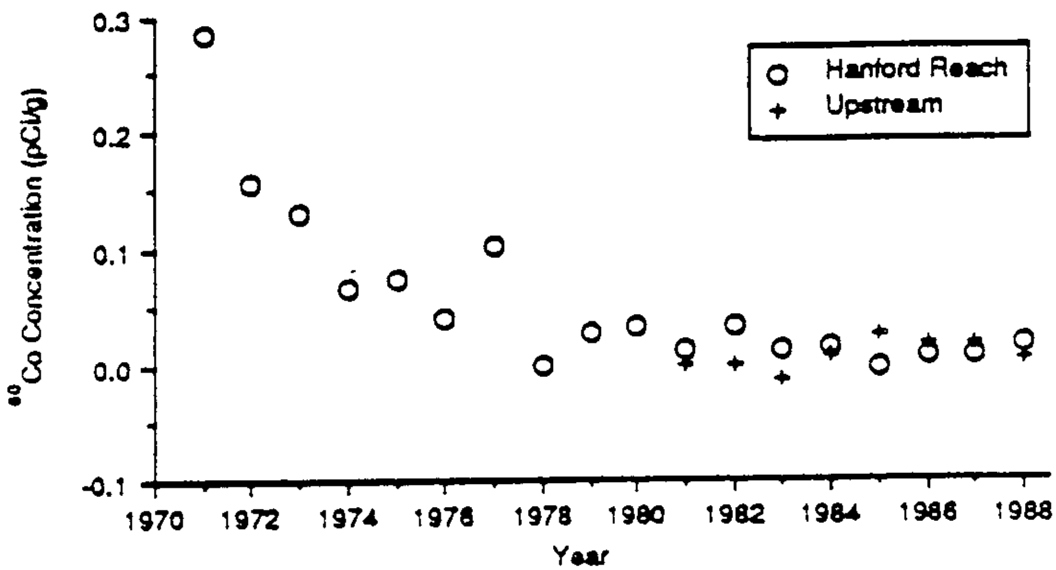

Figure 10. Median Concentrations of ^{60}Co in the Muscle of Whitefish Collected Upstream from the Hanford Site and on the Hanford Reach of the Columbia River (from Eberhardt et al. 1989a).

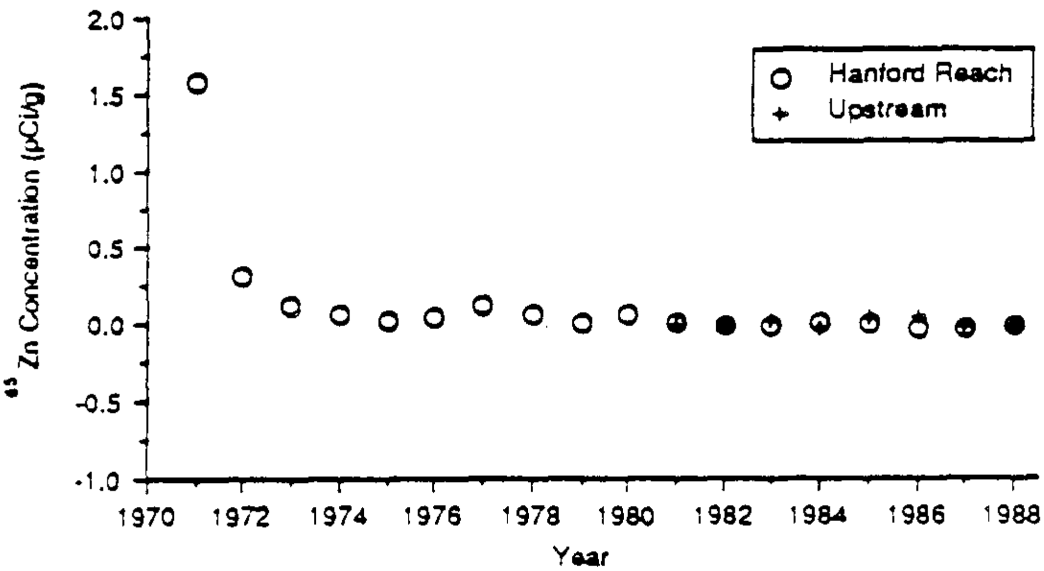

Figure 11. Median Concentrations of ^{65}Zn in the Muscle of Whitefish Collected Upstream from the Hanford Site and on the Hanford Reach of the Columbia River (from Eberhardt et al. 1989a).

The results are given in Figures 12 and 13 and Table 5. Jaquish and Bryce (1990) reported no measurable influence on fish from radionuclides released to the Columbia River during current or past operations at the Hanford Site.

In a 1990 100 Area sampling for the annual Hanford Site Environmental Report, Woodruff et al. (1991) evaluated clams (at 100-N), whitefish (at 100-D, 100-N, and Priest Rapids Dam), bass (at 100-F) and carp (at 100-N) for ^{60}Co, ^{90}Sr, and ^{137}Cs in fish muscle and carcasses (without viscera or fillets). The fillets showed no apparent differences between species, and all concentrations were typically below detection limits. However, ^{90}Sr was detected in all carcasses analyzed. Levels in whitefish collected near the 100-D Area were similar to levels at Priest Rapids Dam (Figure 13). Mean concentrations of ^{90}Sr in bass were approximately 0.03 ± 0.01 pCi/g; in 100-N Area carp, approximately 0.015 ± 0.14 pCi/g. See Figure 14.

Woodruff et al. (1991) also evaluated two clam samples from the 100-N Area; ^{137}Cs was below detection limits, and ^{60}Co and ^{90}Sr were at levels close to detection limits (Table 6). Clams are filter feeders, consuming plankton in the water.

5.1.4 Nonradioactive Contamination in Aquatic Biota

Cushing (1979) examined the levels of trace elements in Columbia River biota to measure trophic-level relationships (the transfer from water, to phytoplankton, to caddis fly larvae, and then to whitefish). Only potassium increased in concentration through the food web; nine elements (silver, cobalt, chromium, cesium, iron, sodium, antimony, scandium, and zinc) decreased in concentration up the trophic levels; and bromine, mercury, rubidium, and selenium remained constant. Chromium in phytoplankton was 22.8 ppm, in caddis fly larvae 1.8 ppm, and in whitefish less than 0.11 ppm; mercury was 0.56 ppm in phytoplankton, less than 1 ppm in caddis fly larvae, and 0.405 ppm in whitefish. These elements are not necessarily contaminants but can provide helpful information in evaluating results from future studies on any monitoring during Site cleanup.

5.1.5 Effects of Contaminants on Aquatic Biota--General

Some radionuclides have affinities for different body organs. For example, $^{89}Sr/^{90}Sr$ accumulates in bone, ^{137}Cs is found in muscle tissue, and ^{60}Co in the spleen (Seymour 1964 as reported in Becker 1990). Technetium-99 (as TcO_4^-) is an analog for sulfate, selenate, molybdate, and phosphate in plants (Cataldo et al. 1989).

Radionuclides tend to be more available in aquatic than terrestrial systems because the solubilizing effect of water increases the biological uptake and concentration (Price 1971). In addition, bottom sediments in aquatic systems can be significant sources of contamination because of physical and biological processes. For example, radionuclides such as cesium may be sorbed onto suspended particulates, then concentrated in filter-feeding animals such as clams and mussels. Price (1971, citing Gustafson 1967), noted that cesium in aquatic systems has a bioaccumulation factor of nine from water to top consumer.

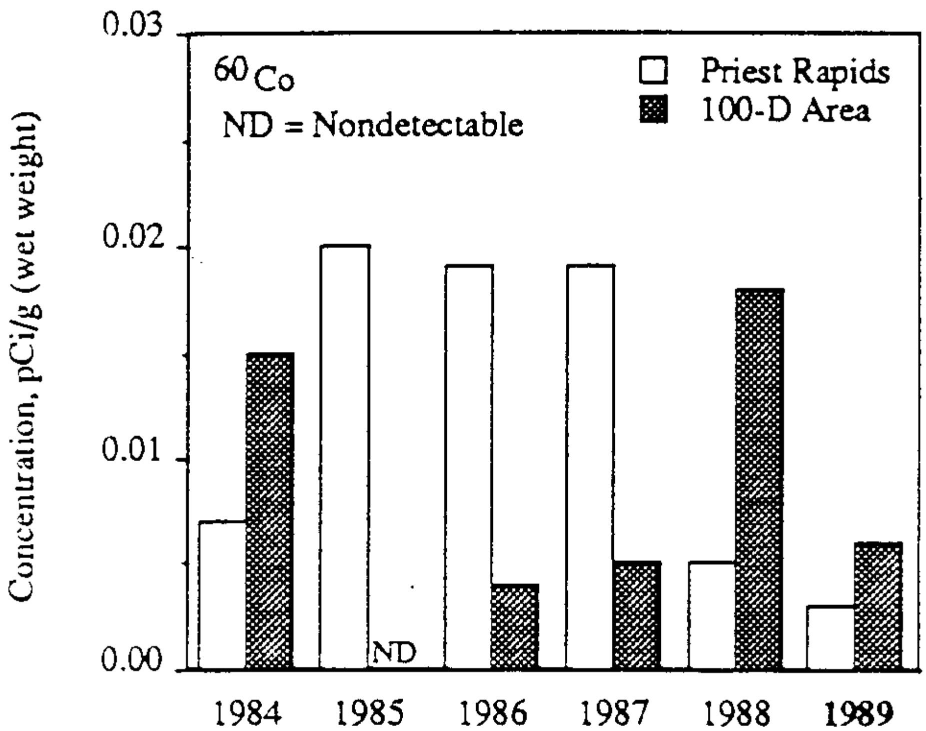

Figure 12. Median Concentrations of ^{60}Co in Whitefish and Bass Collected Near Priest Rapids Dam and Near the 100-D Area, 1984 through 1989 (from Jaquish and Bryce 1990).

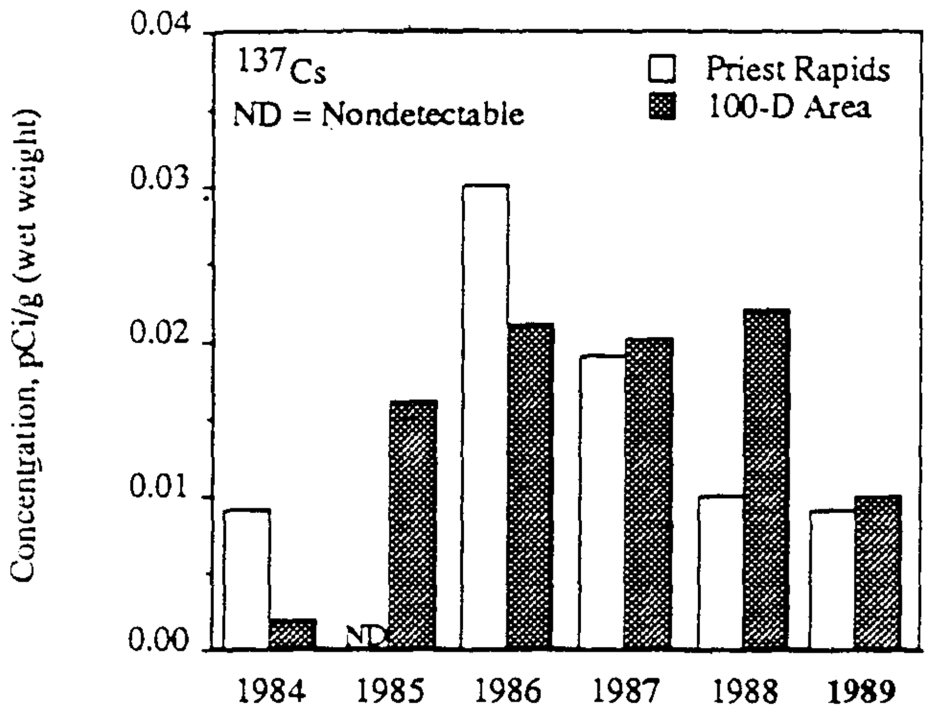

Figure 13. Median Concentrations of ^{137}Cs in Whitefish and Bass Collected Near Priest Rapids Dam and Near the 100-D Area, 1984 through 1989 (from Jaquish and Bryce 1990).

Table 5. Radionuclide Concentrations in Columbia River Whitefish, Salmon, and Bass in 1988 (from Jaquish and Bryce 1989).

Type/location	^{60}Co, pCi/g, wet weight*			^{90}Sr, pCi/g, wet weight*			^{137}Cs, pCi/g, wet weight*		
	Number of samples	Maximum	Average	Number of samples	Maximum	Average	Number of samples	Maximum	Average
Whitefish Muscle Upstream of Site Boundary	5	0.011 ± 0.023	0.005 ± 0.006	5	0.003 ± 0.003	0.001 ± 0.001	5	0.014 ± 0.021	0.008 ± 0.010
100-D Area Vicinity	10	0.035 ± 0.026	0.016 ± 0.012	10	0.005 ± 0.006	0.001 ± 0.001	10	0.039 ± 0.022	0.023 ± 0.010
Whitefish Carcass Upstream of Site Boundary	NS	--	--	5	0.054 ± 0.007	0.031 ± 0.016	NS	--	--
100-D Area Vicinity	NS	--	--	10	0.064 ± 0.005	0.026 ± 0.009	NS	--	--
Bass Muscle 100-F Sloughs	5	0.047 ± 0.033	0.009 ± 0.022	5	0.003 ± 0.003	0.002 ± 0.001	5	0.089 ± 0.046	0.053 ± 0.028
Bass Carcass 100-F Sloughs	NS	--	--	5	0.059 ± 0.008	0.040 ± 0.015	NS	--	--
Salmon Muscle Priest Rapids Dam	5	0.015 ± 0.015	-0.007 ± 0.019	5	0.001 ± 0.002	0.001 ± 0.001	5	0.048 ± 0.021	0.023 ± 0.018
White Bluffs	5	0.010 ± 0.025	0.002 ± 0.013	5	0.002 ± 0.002	-0.001 ± 0.002	5	0.031 ± 0.017	0.017 ± 0.016

*Maximum values ± 2 sigma counting error. Averages ± 2 standard error of the calculated mean.
NS = No sample.

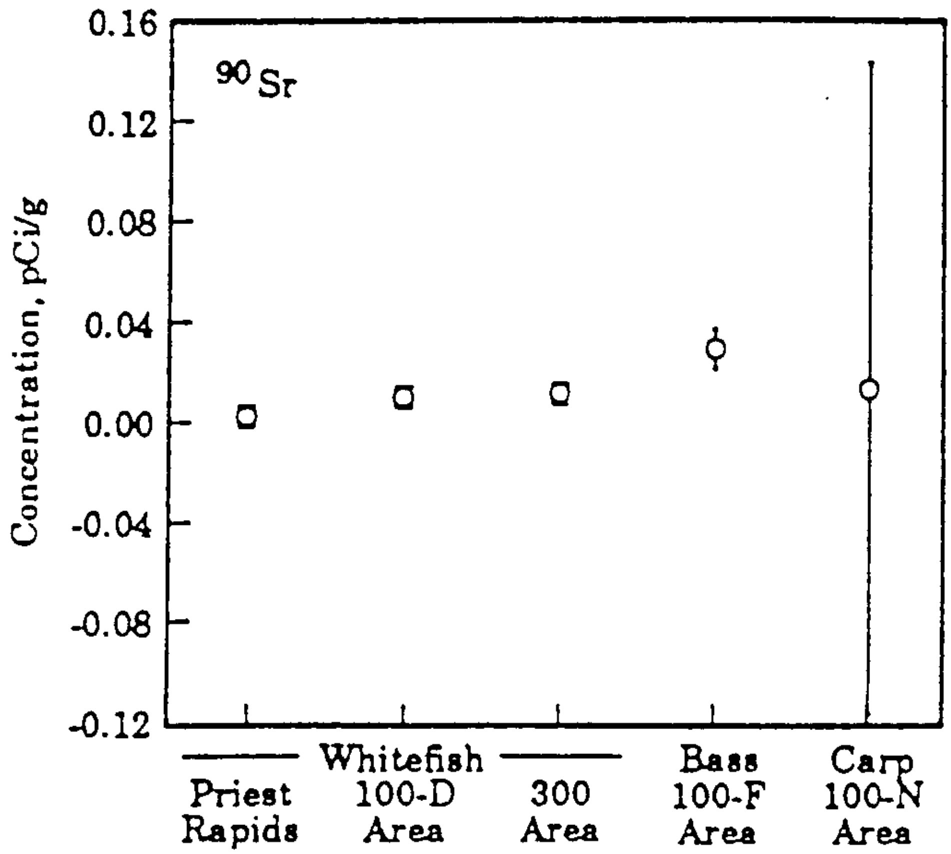

Figure 14. Mean Concentrations of ^{90}Sr in Fish Carcasses Collected from the Columbia River, 1990 (from Woodruff et al. 1991).

Table 6. Radionuclide Concentrations in Two Clam Samples at the 100-N Area (from Woodruff et al. 1991).

Sample number	^{60}Co	^{90}Sr	^{137}Cs
1	0.06 ± 0.03	0.05 ± 0.01	0.004 ± 0.02
2	0.02 ± 0.04	0.02 ± 0.01	0.02 ± 0.03

Emery and McShane (1980) studied whether the amounts of radioactivity in eight ponds and streams (ditches) on the Hanford Site could be related to ecological variations such as productivity. They found no differences in productivity among the sites and no differences from aquatic systems not associated with nuclear waste activities. While one aquatic system (the 100-N trench) contained enough radiation to be harmful to some aquatic organisms, Emery and McShane (1980) found no evidence that the resident biota were influenced. However, they noted that in other literature, more primitive organisms (e.g., algae and invertebrates) showed greater tolerance to radiation than vertebrates.

Dauble et al. (1988) reported that the concentration of contaminants in freshwater organisms depends on the properties and quantity of the contaminant, the properties of the aquatic system (water quality and temperature), feeding habits and relationships among biota, and the metabolic pathways (including storage and elimination) in an organism. Radionuclide concentrations in higher trophic-level organisms tend to be lower than concentrations in their food. Dauble et al. (1988) give as examples uranium, thorium, and radium, which are apparently discriminated against in freshwater trophic chains. Becker (1990) also summarized the importance of the food chain in radionuclide transport. The highest radioactivity levels appeared in plankton, then invertebrates. Invertebrate-eating fish had less, and carnivorous fish the least. ERDA (1975) compared the concentrations of radionuclides in Columbia River organisms from 1957 to 1967 (Table 7). However, tissue contamination concentrations of higher trophic-level organisms may also match or exceed the levels found in the environment.

Davis et al. (1958) also compares radionuclide levels in various Columbia River organisms in the Hanford Reach (Table 8).

Table 7. Comparison of Concentrations of ^{32}P and Gamma-Emitting Radionuclides in Columbia River Organisms 1957 to 1967 (from ERDA 1975). (sheet 1 of 2)

Radionuclide	Year	pCi/g wet weight						
		Plankton	Sessile green algae	Sponge	Caddis fly larvae	Limpet soft parts	Limpet shell	Minnows
^{32}P	1957	--	66,000	4,460	24,300	--	--	24,000
	1966	--		3,270	6,560	3,790	988	7,110
	1967	--	12,800	15,100	28,200	19,000	2,310	
^{46}Sc	1957	--	1,730	94.7	70.6	--	--	0.702
	1967	5,690	3,020	2,130	968	87	475	0
^{51}Cr	1957	--	7,900	4,580	6,000	--	--	372
	1964	59,500	43,400	10,200	3,590	1,940	1,080	--
	1965	28,400	32,900	16,000	4,890	2,260	1,350	--
	1967	12,600	10,200	5,060	3,030	696	1,060	17.6
^{54}Mn	1957	--	1,030	--	79.1			
	1967	791	1,080	603	447	136	359	0
^{59}Fe	1957	--	1,640	--	--	--	--	--
	1967	1,250	1,360	860	537	260	274	28.4
^{60}Co	1957	--	155	11.6	1.72	--	--	--
	1967	41	456	0	7	80	31	0
^{65}Zn	1957	--	12,300	1,460	1,980	--	--	762
	1964	14,000	8,870	3,070	1,970	2,820	658	--
	1965	1,910	3,250	2,500	1,770	1,360	346	--
	1967	4,580	2,050	1,910	1,790	1,560	435	237
^{95}Zr-Nb	1957	--	1,790	--	66.3	--	--	--
	1967	953	380	553	156	109	13	0
^{140}Ba	1957	--	901	--	42.2	--	--	--
	1967	1,910	459	510	367	96	117	0

Table 7. Comparison of Concentrations of ^{32}P and Gamma-Emitting Radionuclides in Columbia River Organisms 1957 to 1967 (from ERDA 1975). (sheet 2 of 2)

Radionuclide	Year	pCi/g wet weight						
		Plankton	Sessile green algae	Sponge	Caddis fly larvae	Limpet soft parts	Limpet shell	Minnows
^{140}La	1957	--	3,270	1,230	347	--	--	--
	1964	5,900	1,610	950	223	73	113	--
	1965	2,010	1,760	1,330	322	107	107	--
	1967	4,630	2,400	2,400	656	333	379	0
^{239}Np	1957	--	2,690	401	311	--	--	--
	1967	3,010	1,750	1,080	384	79	173	0

Table 8. Concentrations of ^{90}Sr and ^{60}Co (pCi/g) in Columbia River Organisms in 1957 (summarized from Davis et al. 1958).

Radionuclide	Algae	Caddis fly larvae	Redside shiners
^{60}Co	1.6×10^{-4}	1.7×10^{-3}	Not given
^{90}Sr	2.1×10^{-4}	1.2×10^{-5}	1.6×10^{-5}

5.1.6 Effects of Contaminants on Aquatic Biota--Specific

Strontium-90--Becker (1990) summarized previous Hanford Site studies on the uptake and effects of ^{90}Sr on trout. The ^{90}Sr activity in trout peaked at 3 weeks at 11×10^{-3} μCi/g, 1.5 times the level in spiked water. The fish retained only 7% of the ^{90}Sr incorporated in the trout food. Feedings of 0.24 μCi damaged the tissues lining the gut (Schiffman 1959 as reported in Becker 1990). Subsequent evaluations of the effects of ^{90}Sr on yearling rainbow trout showed slightly depressed growth and higher mortalities among fish fed the maximum dose of 0.5 μCi/g for 21 weeks. The effects were leukopenia (white blood cell reduction), loss of appetite and weight, listlessness, and lower response to stimuli. Fish fed 0.05 and 0.005 μCi/g daily showed no effects during the study, but there were indications of leukopenia 6 months after treatment in the medium-dose group (Nakatani and Foster 1963, as reported in Becker 1990).

A frame of reference can be provided for these toxicity levels. Dirkes (1990) reported a maximum level of 7,270 + 192 pCi/L for ^{90}Sr in N Springs (converted to 0.00000727 μCi/mL to compare to Schiffman's and Nakatani and Foster's results above). Rokkan (1990) reported the average concentration in N Springs to be 5.9×10^{-6} μCi/mL (converted to 0.0000059 μCi/mL). Although the comparison is between ingested food versus water passing over gills, it is unlikely that the levels of strontium in the N Springs, especially after further dilution by the river, are causing toxic effects in salmonids.

Cesium-137--Cesium-137 was also studied in rainbow trout by intravenous injection of 10 pCi. An analog to potassium, the cesium quickly distributed uniformly through all the soft tissues except for the white muscle. No measurable cesium accumulated in the bone, and activity declined in all soft tissue but the white muscle after 6 hours. Cesium-137 half-time was 1-1/2 days in red muscle and 13 days in white muscle (Dean et al. 1965 as reported in Becker 1990). However, the half-time of ^{137}Cs in 5 °C water was 20 days, twice the half-time at 18 °C (Dean and Nakatani 1966 as reported in Becker 1990).

Closed-system microcosm studies of bioaccumulation (Pendleton 1965) showed that algae, macrophytes, grass, fish, and frogs all accumulated ^{137}Cs over 17 months. The concentration factors ranged from 50 to 14,000 times the level in the pond water (6 x 10 μCi/mL). While radioactivity decreased in the organisms by loss to sediment and partitioning among increasing biomass, the highest activities were at the highest trophic levels. Aquatic plants were reservoirs of ^{137}Cs and a pathway to ducks. As reported earlier, Dirkes (1990) reported less than background results for ^{137}Cs in springs from the N and H Areas.

Tritium--Strand et al. (1976, as reported in Becker 1990) studied tritium uptake in periphyton, macrophytes, snails, clams, and fish. Tritiated water was introduced continuously at 1 μCi/L for 8 months. While all organisms rapidly took up the tritium, the concentrations never reached equilibrium with the water in any biota. All organisms rapidly lost tritium when the spiking ceased. Strand et al. (1972, as reported in Becker 1990) examined survival of rainbow trout eggs to levels of tritium varying from 0.01 to 10.0 μCi/mL for 28.5 days at 10.6 °C. No negative effects were detected. However, trout eggs exposed to various levels of tritium [0.04 to 40 roentgen (R)] for 20 days showed permanent suppression of the immune response at the 4.0- and 40-R doses.

Jaquish and Bryce (1990) report a maximum concentration of tritium in the Columbia River at the 300 Area in 1989 to be 195 pCi/L (0.000000195 μCi/mL), and at Priest Rapids, 79 pCi/L (0.000000079 μCi/mL). Rokkan (1990) estimated a conservative average concentration of 0.000062 μCi/mL tritium from N Springs. Tritium does not appear to be bioaccumulated, and there is little information on the effects of tritium at the levels reported.

Technetium-99--While the bioavailability and toxicity of ^{99}Tc to plants has been established (see Cataldo et al. 1989, Gerber et al 1989), its toxicity to rats appears to be small (Gerber et al. 1989). Studies of technetium in a marine environment [(Koyanagi et al. 1990), no levels of technetium in the water were given] showed low concentration factors for fish, crabs, bivalves, and octopus, but high concentration factors for seaweeds and gastropods eating the seaweeds.

Chromium (VI)--Sodium dichromate was added to reactor cooling water to inhibit corrosion and was the primary chemical of concern in the effluent. Becker (1990) summarized past studies of sodium dichromate and chromium toxicity. Chinook salmon and rainbow trout were reared from eggs in sodium dichromate; eggs hatched in the highest concentration of 0.18 ppm hexavalent chromium [Cr (VI)], but survival of fry and fingerlings was adversely affected by 0.08 ppm Cr (VI), and growth was retarded at the lowest level of 0.013 ppm. The effects on young salmon were less from intermittent than constant exposure. The bioassays led to locally recommended limits of 0.02 ppm Cr (VI) in the Columbia River.

Groundwater maps of chromium plumes (Evans et al. 1990) show the heaviest concentrations of chrome (VI) in 1989 to be at the 100-D and 100-H Areas. These maps indicate that the levels of Cr (VI) entering the river at the 100-D Area were between 100 and 200 μg/L (0.1 and 0.2 ppm, along a 1,000-m stretch, and for these purposes, considered undiluted by the bank storage effect). The levels entering the river at 100-H were between 50 and 150 μg/L (0.05 and 0.15 ppm, along a 700-m stretch, and undiluted by the bank storage effect). Dauble and Watson (1990) identified the Columbia River near the 100-H and 100-D Areas as being a major spawning area for salmon (see Figure 1). However, assuming that the maximum strength of Cr (VI) in groundwater (0.2 ppm) is entering the river undiluted through a spring in the bottom of a redd, it is still unlikely to affect the survival of the eggs (see above). While this level is an order of magnitude above that recommended for fingerlings, the concentration of chromium entering the river is quickly diluted by the overwhelming quantity of water in the Columbia and is unlikely to have significant effect.

5.2 TERRESTRIAL BIOTA

5.2.1 Surface Contamination

From May 13 to July 9, 1979, Sula (1980) performed a comprehensive ground-based survey of islands and shorelines along the Columbia River to determine the status and extent of radiation levels in areas above the water level. Nearly 30,000 measurements were made over 21 million square meters of land, surveying 40 mi of shoreline and 26 islands. This is approximately 60% of the affected area between the 100-B Area and Two Rivers Park in Finley. Measurable radionuclides from past Hanford Site operations were present along the shore downstream from the 100-B Area. Short-lived radionuclides were absent, and longer lived contamination was present several meters above the current maximum river levels, indicating deposition from several years previous to the study. The dominant radionuclides in the sediments were ^{60}Co, ^{152}Eu, and ^{137}Cs (Table 9).

Table 9. Concentrations of Radionuclides From the 100 Areas and Downstream (from Sula 1980).

Location	Concentration (pCi/g wet weight)		
	^{60}Co	^{137}Cs	^{152}Eu
N Area Shore			
Vegetation*	1.0	0.09	Not detected
Soil	7.4	2.9	Not detected
F Area Slough			
Vegetation*	Not detected	0.04	Not detected
Soil	0.29	0.52	0.33
McMurray St. Shore			
Vegetation*	0.13	0.10	Not detected
Soil	0.88	0.44	0.65

*Vegetation not identified as to species.

The contamination had three types of distribution: (1) a constant, uniform distribution over much of the study area; (2) localized areas of concentrated contamination at 92 locations, primarily in areas of heavier vegetation, where finer-grained soil and their bound nuclides were able to settle out of suspension in the water; and (3) discrete particles containing ^{60}Co, primarily in flat, rocky areas devoid of vegetation.

The external dose rate from the types 1 and 2 distribution were below applicable external radiation protection dose limits for uncontrolled areas. Sula (1980) estimated that the type three distribution was also unlikely to produce health effects because of the beta radiation and extreme nonconformity of the radiation field.

In the summer of 1988, Reiman and Dahlstrom (1990) conducted an aerial radiation survey of the river shore. The H, F, and Hanford Townsite sloughs showed increased radiation levels over background, probably from radionuclides settling out during past high water flows.

5.2.2 Terrestrial Flora

Facility-specific environmental surveillance of the Hanford Site 100 Areas was conducted for a number of years under the auspices of United Nuclear Corporation Nuclear Industries and for the past four years by Westinghouse Hanford. This program provides sampling and monitoring of several parameters, including vegetation, to evaluate the environmental impact of 100-N Area reactor facilities and the shut down reactor facilities and burial grounds in the retired 100 Areas (see Perkins 1991 for the latest report in this series).

The ongoing surveillance of the 100 Areas by Westinghouse Hanford permits an evaluation of radionuclide distribution in vegetation from airborne releases and uptake from soil. Vegetation samples of 500 g are collected from the growing portion of perennial vegetation. Gray rabbitbrush is the predominant species sampled, but perennial grass growing at the N Springs is also sampled. Sample locations from the N Area are shown in Figure 15. Results from the N Area from 1980 to 1989 are shown in Tables 10 through 15 (Perkins 1991). The maximum level Perkins (1991) detected for ^{90}Sr in 1989 was 330 pCi/g, with an average of 80 pCi/g. The Hanford Site average was 0.062 pCi/g in 1989. Although vegetation is taking up measurable levels of radionuclides in the N Area, vegetation samples from other retired reactor facilities indicated no elevated levels of radionuclides when compared to the Hanford Site average concentrations (Perkins 1991).

Rickard and Price (1990) sampled both reed canary grass and goose eggshells along the Columbia River in 1986. Results for ^{90}Sr levels in reed canary grass from the 100-N Area ranged from approximately 50 to 0.25 pCi/g. Perkins (1991) reported an average of 220 pCi/g ^{90}Sr from N Springs grass in 1986. Rickard and Price reported an average concentration of 1.621 pCi/g ^{90}Sr in goose eggshells near the N Springs (Plow Island), versus 0.847 pCi/g from eggshells from the Snake River (New York Island) and 0.99 pCi/g from goose eggshells 160 km upriver (Bridgeport) from the Hanford Site.

Perkins (1991) reported that similar vegetation (gray rabbitbrush) surveys in all the other 100 Areas indicate no elevated levels of radionuclides compared to the Hanford Site average concentrations.

A Site-wide program has been conducted for more than 20 years by PNL. Numerous environmental media on and off the Site are sampled in this study (see Woodruff et al. 1991). Jaquish and Bryce (1990) also reported sampling results for onsite and offsite vegetation. The 100 Areas vegetation sampled

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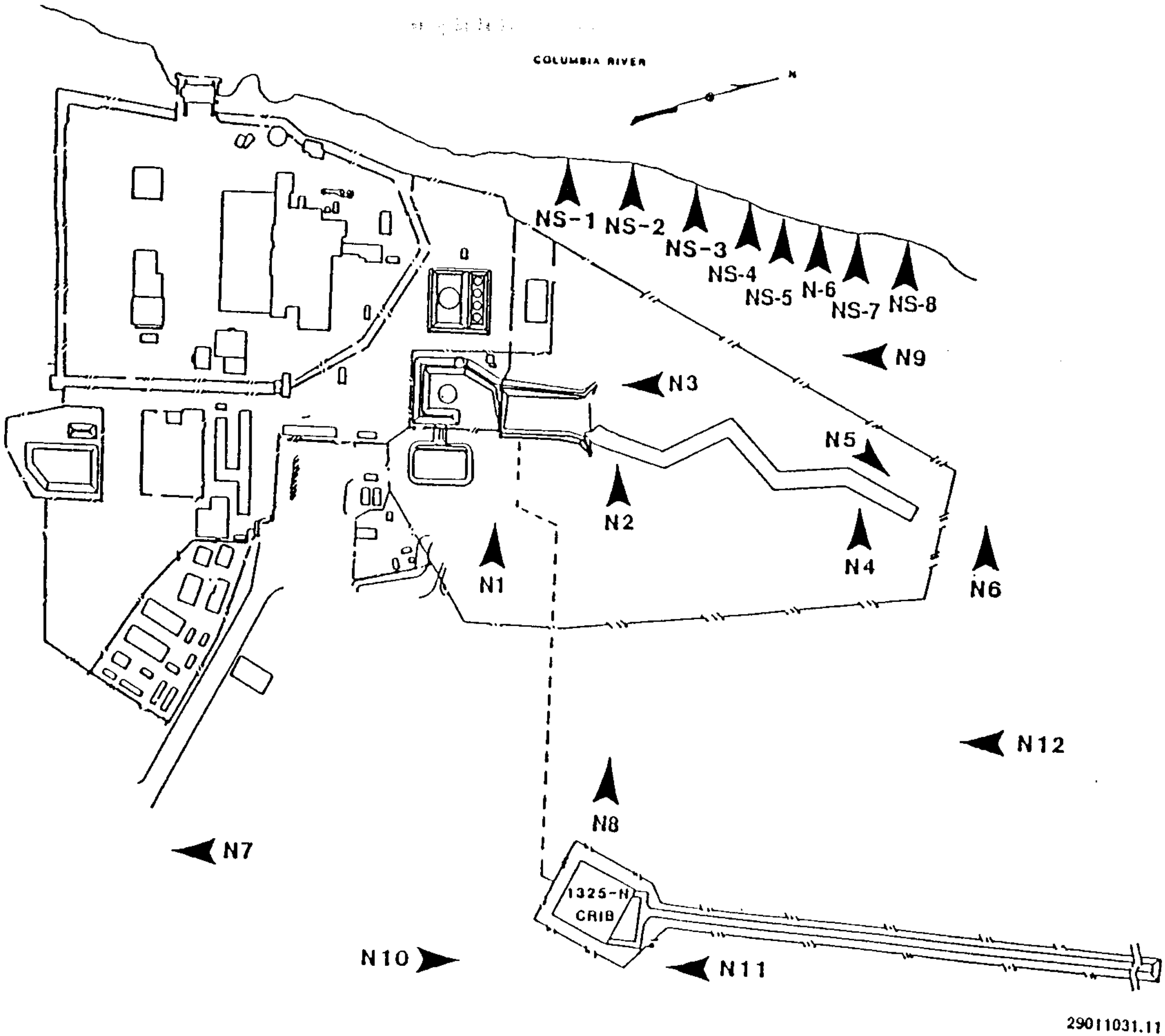

Figure 15. Vegetation Sampling Locations at 100-N Area (from Jacques 1987).

Table 10. Average Radionuclide Concentrations (pCi/g) Detected in Vegetation Samples Near the 1301-N Liquid Waste Disposal Facility from 1980 to 1989 (from Perkins 1991).

Year	^{54}Mn	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	^{239,240}Pu
1980	1.4 E+00	4.0 E+00	NR	1.1 E+00	NR	NR
1981	2.5 E+00	1.2 E+01	1.8 E+00	1.8 E+00	NR	7.1 E-03
1982	4.6 E-01	1.6 E+00	1.2 E-01	2.6 E-01	NR	2.6 E-03
1983	4.5 E-01	1.9 E+00	6.0 E-01	3.9 E-01	NR	3.2 E-03
1984	2.9 E-01	1.0 E+00	1.2 E-01	8.3 E-02	NR	8.5 E-04
1985	5.9 E-01	1.7 E+00	1.9 E+00	1.0 E-01	NR	1.5 E-03
1986	6.8 E-01	3.5 E+00	7.3 E-02	6.5 E-01	NR	2.6 E-03
1987	4.9 E-01	2.8 E+00	6.3 E-02	2.0 E-01	1.2 E-03	5.6 E-03
1988	1.5 E-01	2.0 E+00	1.2 E-01	1.3 E-01	4.3 E-04	1.7 E-03
1989	<1.1 E-01	1.3 E+00	3.8 E-02	1.5 E-01	2.8 E-04	2.0 E-03

NOTE: Table 13 lists the results of the analysis of 1301-N LWDF vegetation samples.

NR = Not reported.

Table 11. Average Radionuclide Concentrations (pCi/g) Detected in 100-N Vegetation Samples from 1980 to 1989 (from Perkins 1991).

Year	^{54}Mn	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	^{239,240}Pu
1980	4.8 E-01	1.0 E+00	NR	2.8 E-01	NR	NR
1981	1.8 E+00	2.5 E+01	5.8 E-01	7.1 E-01	NR	2.1 E-02
1982	4.9 E-01	1.5 E+00	2.0 E-01	1.3 E-01	NR	7.8 E-03
1983	3.6 E-01	1.0 E+00	2.9 E-01	9.0 E-02	NR	8.6 E-03
1984	1.3 E-01	4.6 E-01	8.1 E-02	9.0 E-02	NR	1.3 E-03
1985	3.6 E-01	1.4 E+00	5.1 E-02	1.6 E-01	NR	8.7 E-04
1986	2.6 E-01	9.5 E-01	2.2 E-01	7.9 E-01	NR	1.1 E-03
1987	1.1 E-01	7.0 E-01	2.6 E-01	9.4 E-02	1.3 E-04	5.8 E-04
1988	1.3 E-01	8.0 E-01	2.5 E-01	1.6 E-01	1.7 E-04	6.6 E-04
1989	<7.8 E-02	3.2 E-01	6.8 E-02	1.5 E-01	1.1 E-04	8.7 E-04

NOTE: Table 14 lists the results of the analysis of 100-N Area vegetation samples.

NR = Not reported.

Table 12. Radionuclide Concentrations (pCi/g) Detected in N Springs Vegetation Samples from 1980 to 1989 (from Perkins 1991).

Year	^{54}Mn	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	^{239,240}Pu
1980	1.5 E-01	5.6 E+00	NR	4.4 E-01	NR	NR
1981	NR	3.3 E+00	2.0 E+02	NR	NR	3.7 E-03
1982	1.5 E-01	2.8 E+00	4.8 E+02	NR	NR	8.3 E-03
1983	7.0 E-02	3.0 E+00	3.3 E+02	4.0 E-02	NR	8.0 E-03
1984	NR	NR	NR	NR	NR	NR
1985	7.6 E-02	1.2 E+00	4.2 E+02	1.7 E-01	NR	4.4 E-04
1986	1.6 E-01	1.1 E+00	2.2 E+02	2.1 E-01	NR	4.2 E-04
1987	2.0 E-01	9.0 E-01	2.9 E+02	1.1 E-01	<1.3 E-04	7.6 E-04
1988	2.4 E-01	1.4 E+00	1.2 E+02	2.0 E-01	8.5 E-05	2.0 E-04
1989	<1.3 E-01	4.3 E-01	8.0 E+01	1.5 E-01	1.1 E-03	4.5 E-04

NOTE: Table 15 lists the results of the analysis of N-Springs vegetation samples.

NR = Not reported.

Table 13. Radionuclide Concentrations (pCi/g, dry weight) Detected in Vegetation Samples Near the 1301-N LWDF (from Perkins 1991).

Sample location*	Sample type	^{54}Mn	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	^{239,240}Pu
N-1	V	<1.9 E-01	5.7 E-01	2.2 E-02	<1.8 E-01	1.9 E-04	9.2 E-04
N-2	V	<1.0 E-01	4.3 E+00	4.8 E-02	2.0 E-01	5.7 E-04	5.0 E-03
N-3	V	<9.0 E-02	9.4 E-01	8.3 E-02	6.6 E-02	4.1 E-04	3.3 E-03
N-4	V	<8.7 E-02	4.4 E-01	2.8 E-02	2.4 E-01	<4.0 E-06	4.9 E-04
N-5	V	<1.0 E-01	3.9 E-01	9.2 E-03	7.5 E-02	2.4 E-04	3.9 E-04
Average		<1.1 E-01	1.3 E+00	3.8 E-02	1.5 E-01	2.8 E-04	2.0 E-03
Standard deviation		3.9 E-02	1.5 E+00	2.6 E-02	7.0 E-02	1.9 E-04	1.8 E-03
Hanford Site**		NR	NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

*Locations identified in Figure 15.
**Average values obtained for Pacific Northwest Laboratory (PNL)-6825.

NR = Not reported.

Table 14. Radionuclide Concentrations (pCi/g, dry weight) Detected in 100-N Vegetation Samples (from Perkins 1991).

Sample location*	Sample type	^{54}Mn	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	$^{239,240}Pu$
N-6	V	<7.1 E-02	2.8 E-01	1.3 E-02	5.0 E-01	3.4 E-04	8.9 E-04
N-7	V	<8.7 E-02	2.0 E-01	1.0 E-01	1.2 E-01	6.9 E-05	1.2 E-03
N-8	V	<6.3 E-02	2.6 E-01	3.1 E-02	8.9 E-02	9.5 E-05	1.2 E-03
N-9	V	<9.4 E-02	2.9 E-01	1.9 E-01	<9.4 E-02	<8.5 E-06	9.3 E-04
N-10	V	<6.9 E-02	1.6 E-01	5.2 E-02	6.6 E-02	<4.8 E-05	8.2 E-04
N-11	V	<7.3 E-02	7.5 E-01	6.5 E-02	<7.3 E-02	<8.5 E-06	1.0 E-03
N-12	V	<9.1 E-02	2.9 E-01	2.7 E-02	<8.0 E-02	2.0 E-02	4.4 E-05
Average		<7.8 E-02	3.2 E-01	6.8 E-02	1.5 E-01	1.1 E-04	8.7 E-04
Standard deviation		1.1 E-02	1.8 E-01	5.6 E-02	1.5 E-01	1.1 E-04	3.6 E-04
Hanford Site**		NR	NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

*Locations identified in Figure 15.
**Average values obtained for Pacific Northwest Laboratory (PNL)-6825.

NR = Not reported.

Table 15. Radionuclide Concentrations (pCi/g, dry weight) Detected in N Springs Vegetation Samples (from Perkins 1991).

Sample location*	Sample type	^{54}Mn	^{60}Co	^{90}Sr	^{137}Cs	^{238}Pu	^{239,240}Pu
NS-1	V	<4.5 E-02	3.3 E-01	1.5 E+02	<5.0 E-02	<1.7 E-05	6.8 E-04
NS-2	V	<4.0 E-02	1.6 E-01	3.3 E-02	7.9 E-02	1.3 E-04	5.5 E-04
NS-3	V	<8.8 E-02	1.1 E-01	7.8 E+01	1.8 E-01	1.9 E-04	2.0 E-04
NS-4	V	<2.1 E-01	5.8 E-01	2.4 E+00	2.2 E-01	8.3 E-03	1.1 E-04
NS-5	V	NR	NR	1.2 E+01	NR	1.8 E-04	2.8 E-04
NS-6	V	<1.6 E-01	7.3 E-01	3.3 E+01	<1.5 E-01	<1.6 E-05	1.8 E-04
NS-7	V	<2.8 E-01	8.3 E-01	2.9 E+01	<2.6 E-01	<6.0 E-05	<8.1 E-04
NS-8	V	<1.2 E-01	2.7 E-01	5.0 E+00	<1.2 E-01	<8.5 E-06	7.8 E-04
Average		<1.3 E-01	4.3 E-01	8.0 E+01	1.5 E-01	1.1 E-03	4.5 E-04
Standard deviation		8.2 E-02	2.6 E-01	1.1 E+02	7.0 E-02	7.0 E-03	2.7 E-04
Hanford Site**		NR	NR	6.2 E-02	3.3 E-02	NR	7.1 E-04
Offsite**		NR	NR	3.5 E-02	1.1 E-02	NR	2.6 E-04

*Locations identified in Figure 15.
**Average values obtained for Pacific Northwest Laboratory (PNL)-6825.

NR = Not reported.

(sagebrush, rabbitbrush, and bitterbrush, collected in approximately the ratios found growing at each site) came from one mile northeast of the 100-N Area (site 1), 1 mi east of the 100-N Area (site 2), and the 100 Area fire station (site 3). The pertinent results, in pCi/g dry weight, are shown in Table 16.

Table 16. Radionuclide Concentrations (units pCi/g) in Vegetation Near the 100-N Area (from Jaquish and Bryce 1990).

Site (see text)	^{90}Sr	^{137}Cs	$^{239,240}Pu$
1	0.071 ±0.007	0.014 ±0.016	0.00033 ±0.00030
2	0.10 ±0.01	0.013 ±0.018	0.00037 ±0.00031
3	0.060 ±0.005	0.020 ±0.017	0.00038 ±0.00024
Offsite (average)	0.052 ±0.013	0.007 ±0.003	0.00010 ±0.00004

NOTE: Vegetation was also analyzed for uranium, which was slightly higher offsite than onsite.

Tritium was measured in leaf water extracted from six black locust trees growing near the 100-K Area (maximum concentration was 12,000 pCi/L). This was greater than the concentrations of tritium in well water sampled near the trees (Rickard and Price 1989) and shows that tritium is in a biotic pathway.

In 1990, PNL sampled mulberry tree leaves and berries and curly dock at the 100-N Area. The results are shown in Table 17 (conversions from dpm/g and Bq/g to pCi/g are shown in brackets). The highest result for ^{90}Sr is 77 pCi/g, in mulberry leaves; for ^{137}Cs the highest result is 0.025 pCi/g, in mulberries.

5.2.3 Terrestrial Fauna

A discussion of ^{90}Sr levels in goose eggshells as they relate to reed canary grass was presented above. Jaquish and Bryce (1990) found the levels of ^{137}Cs in three geese in 1989 at the 100-D Area to be at the levels expected from worldwide fallout (^{90}Sr levels were not analyzed for).

During the 1960-1961 waterfowl season, Hanson and Case (1963) tracked 601 ducks and geese contaminated with ^{65}Zn and ^{32}P from stopovers on the Hanford Site. Forty-one percent of the birds harvested within a 50-mi radius of the Hanford Site showed Hanford-related contamination. Hanson and Case (1963) noted that "The amounts of radionuclides accumulated in the waterfowl were far below levels that would be hazardous to the birds or their consumers." At the time of their study (1960-1961), most of the production reactors were operating, and many of the highly contaminated waste disposal ponds and trenches were accessible to waterfowl.

Table 17. Hanford Site Vegetation Samples 100-N Springs Area (from Rickard and Price 1989).

Sample	Strontium-90 dpm/g wet (pCi/g)	Gamma results* Bq/g wet (±%)	pCi/g
<u>Mulberry samples</u> Location 1 90182 53289-2 mulberries	Not available	^{7}Be <0.0085 ^{40}K <0.01 ^{60}Co <0.0017 ^{137}Cs <9.2E-4	0.23 0.27 0.046 0.025
Location 2 90185 53289-5 mulberry leaves	Not available	^{7}Be 0.024 (8.1) ^{40}K <0.14 ^{60}Co 4.40E-4(37) ^{137}Cs 1.23E-3(35)	0.648 3.78 0.012 0.0332
90183 53289-3 mulberries	Not available	^{7}Be 0.0047 (28) ^{40}K <0.11 ^{60}Co 0.0037(5.9) ^{137}Cs <3.0E-4	0.127 2.97 0.1 0.0081
Location 3 90181 53289-1 mulberry leaves	171 (77)	^{7}Be 0.025 (9.8) ^{40}K 0.195 (28) ^{60}Co 8.59E-4(23) ^{137}Cs 8.20E-4(50)	0.675 5.265 0.023 0.022
90184 53289-4 mulberries	41.9 (19)	^{7}Be 0.0046 ^{40}K <0.091 ^{60}Co 8.42E-4(16) ^{137}Cs 5.08E-4(50)	0.124 2.457 0.0227 0.014
<u>Curly dock sample</u> Location 4 90186 53289-6 curly dock, plant and root, 50' ds of well N-8	181 (81)	^{7}Be 0.0035 (35) ^{40}K <0.067 ^{60}Co 1.21E-3(18) ^{137}Cs <5.0E-4	0.0945 1.809 0.033 0.0135

*The analytical uncertainty is the one-sigma value expressed as a percent.

Location 1 = Below 100-N stack on near shoreline.
Location 2 = ~50 m upstream of N-8 groundwater well near shoreline.
Location 3 = ~50 m downstream of N-8 groundwater well near shoreline.
Location 4 = ~15 m downstream of N-8 groundwater well at shoreline.

Radionuclide trends studied by Eberhardt et al. (1989b) showed that ducks from the Hanford Site waste-water ponds had 10 to 1,000 times the level of ^{137}Cs in ducks from the Hanford Reach before the early 1980's. The maximum level was 13,800 pCi/g of ^{137}Cs in a mallard collected in 1978 from the 100-N Trench. The maximum concentration of ^{137}Cs in four ducks from the Columbia River in 1988 was 0.03 pCi/g. Eberhardt et al. (1989b) report that the concentration of ^{137}Cs in waterfowl muscle from 1982 through 1988 from the Hanford ponds has declined from earlier periods, probably from decommissioning 200 Area ponds and ditches.

In 1990 sampling for the Hanford Site Environmental Report (Woodruff et al. 1991), ducks collected from the 100-N Area showed no detectable levels of ^{137}Cs, ^{90}Sr, or ^{60}Co.

The great blue herons that nest on the Hanford Site feed mostly on Columbia River fish and can serve as biological indicators of chemical contamination in the riparian environment. Toxic metals, such as lead, cadmium, and mercury, have been measured in the nest debris (feces and food scraps) at one Hanford Site heron rookery. The levels of these metals found in herons on the Hanford Site are lower than these reported elsewhere in the Northwest (Fitzner et al. 1982). Heavy metal concentrations have also been examined in eggs and in young herons from the Hanford Site. No elevated levels were detected for lead, copper, zinc, or mercury. These data however, provide a useful baseline for comparison to future years. Fitzner et al. (1988) found the heron rookery at White Bluffs had low measurable concentrations of PCBs and DDE, but these organochlorine residues seemed to exert little influence on reproductive success. The residues probably originated on heron wintering grounds.

In May 1956, an unplanned release was observed and recorded when swallows used mud from the 107-H liquid waste trench to build nests. The nests were removed, and exposed mud at the trench was covered with gravel (ERDA 1975). Similar situations are possible elsewhere on the Hanford Site, where contaminated mud or sediments are accessible to swallows.

Jaquish and Bryce (1991) reported the 1989 levels of ^{137}Cs in the breast meat of 10 pheasants from the 100 Areas to average 0.20 ±0.39 pCi/g, with a maximum of 2.0 ±0.1 pCi/g. They attributed these levels to worldwide fallout (see Figure 16 for sampling locations).

Birds of prey, particularly owls, have been implicated in the spread of radionuclides near the 100-D, 100-F, and 100-H Reactors (Cadwell and Fitzner 1984). Pellets (regurgitated undigestible prey remains) from great horned owls, barn owls, red-tailed hawks, and Swainson's hawks were collected from 1975 through 1978. Two samples (one great horned owl and one barn owl) were collected from near retired production reactors and were examined for gamma-emitters. These samples contained (no specific levels reported) ^{54}Mn, ^{60}Co, ^{137}Cs, and ^{152,154,155}Eu, demonstrating that small animals were mobilizing radionuclides. Mean ^{137}Cs concentration for barn owl pellets collected near the 100-D, 100-F, and 100-H Areas was 3.1 (±1.1) pCi/g. Pellet analysis indicated these owls were feeding mostly on small mammals, especially Great Basin pocket mice. Eight of the nine Swainson's hawk samples (mostly from the 200 Area) showed background levels of ^{137}Cs, a reflection of the hawk's diet (predominately snakes).

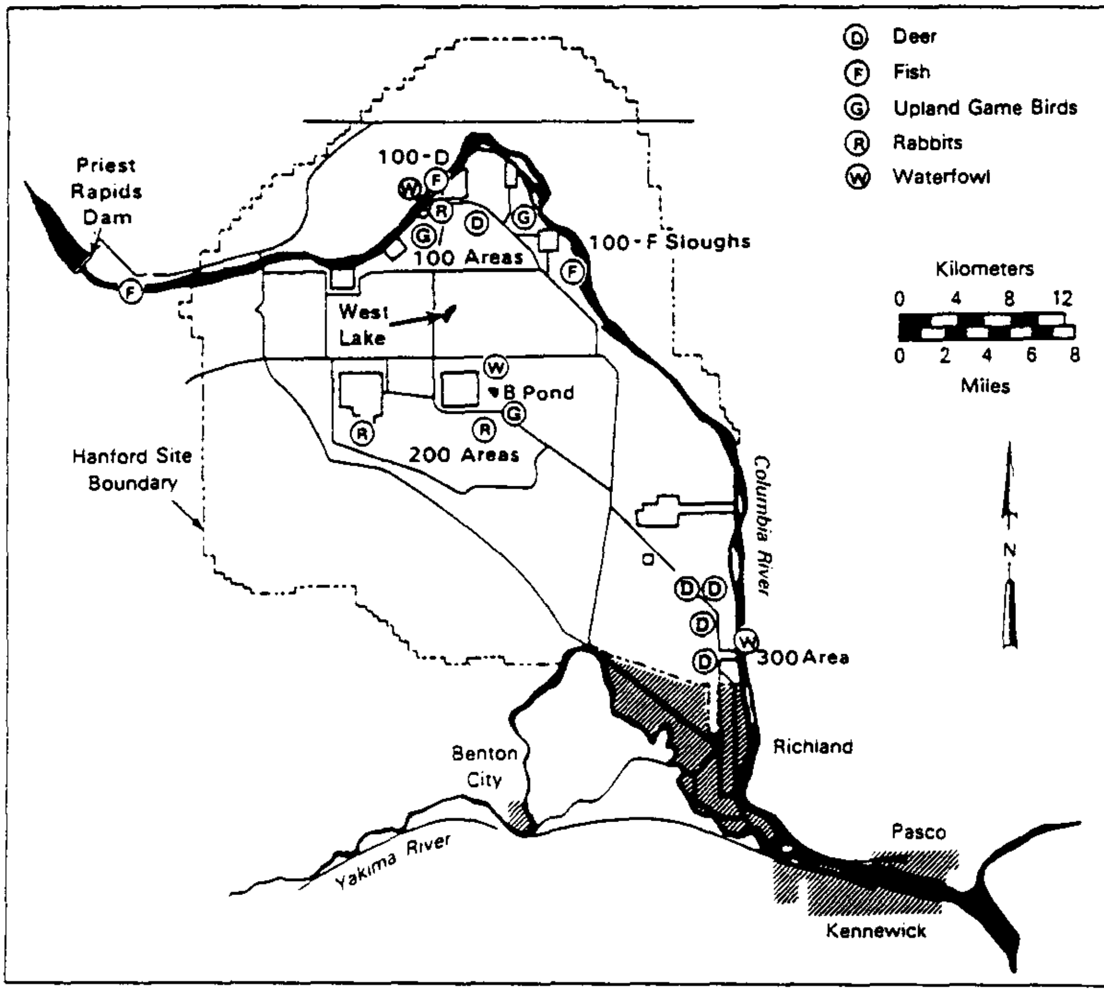

Figure 16. Wildlife Sampling Areas (from Jaquish and Bryce 1990).

Eberhardt et al. (1989b) summarized ^{137}Cs levels (picocuries per gram) in Hanford Site mice (mostly near the 100-N Trench) for the 1975 through 1978 period (Table 18).

Table 18. Cesium-137 Levels (pCi/g wet weight) in Mice (from Jacques 1986).

Level	Year			
	1975	1976	1977	1978
Sample size	10	29	15	17
Median	4.0	1.7	0.4	1.6
Maximum	717	5,560	3,370	2,920

Jacques (1986) reported ^{137}Cs levels for 1985 in mice near the 1301-N liquid waste disposal facility averaged 640 pCi/g, ranging from 2,700 to 2.2 pCi/g in 16 mice. The trench has since been closed to wildlife intrusion by construction of a barrier.

In May 1977, Uresk and Uresk (1980) found average levels of ^{137}Cs in deer pellets up to 16.0 ±3.6 pCi/g from the three sites in the 200 Areas, with average levels in control samples from Utah of 0.5 ±0.9 pCi/g. In deer pellets from Gable Mountain Pond and B Pond, ^{90}Sr levels ranged up to 184.3 pCi/g, with willow and Russian thistle having the highest frequency of food species occurrence in the pellets.

Hedlund (1975) reported comparable levels of ^{137}Cs (0.1 pCi/g wet weight) in deer meat from animals killed on the Hanford Site and in the mountains of Colorado, suggesting that the cesium in deer ranging on the Hanford Site is primarily from worldwide fallout. Other studies (Eberhardt et al. 1984) found ^{137}Cs levels up to 3.43 pCi/g dry weight in deer meat from animals who spent a large amount of time near 200 Area waste ponds (May 1981). They also found up to 65 pCi/g ^{90}Sr in the bones of deer near a waste pond (December 1981). Control animals from the 100 and 400 Areas had maximum levels of 0.04 pCi/g dry weight ^{137}Cs in deer meat and 3.0 pCi/g ^{90}Sr in bones (March 1982).

Eberhardt et al. (1984) concluded that the uniform concentration of ^{137}Cs in meat of the control deer was at background levels, matching that in deer from a distance of 270 km. However, higher variability of ^{137}Cs in deer near the 200 Areas suggests that heterogeneity of contamination in the environment may result in varying concentrations in individuals and with time. The longer the animals feed away from contamination sources, the lower the burden through biological loss: ^{137}Cs has a reported biological half-time in deer of 14 days; ^{90}Sr is reported to be 170 days (Eberhardt et al. 1984 [Dauble et al. (1988) give the biological half-times of ^{90}Sr in aquatic organisms to be 11 years]). Two 200 Area deer radio-tracked by Eberhardt et al. (1982) were killed 4 to 5 months after moving away from the 200 Areas. Thus, 99.7% of the ^{137}Cs that might have been in their meat from feeding in the 200 Areas had been biologically eliminated in the 4 to 5 months. Of the eight deer moving from the 200 Areas to hunting areas, five moved more than 3 months before the legal hunting season, resulting in little potential for ingestion by man of this ^{137}Cs. The ultimate fate of the ^{137}Cs in these and the other three deer, whether most is dropped as feces on or off the Hanford Site, is not known. The feces will decompose and join the organic material in the soil, where it eventually becomes available for uptake by plants.

Jaquish and Bryce (1990) reported levels of ^{137}Cs and $^{239,240}Pu$ in the muscle and liver, respectively, of five deer from the Hanford Site; one from the 100 Areas and four from near the 300 Area. Levels were low to nondetectable in the range attributable to worldwide fallout (see Figure 15 for sampling locations). Woodruff et al. (1991) found ^{90}Sr ranges of 0.7 to 58 pCi/g in the bones of two deer from the 100-N Area in 1990 sampling. Levels of approximately 1.0 pCi/g are attributable to fallout; thus the deer were probably exposed to elevated levels of environmental ^{90}Sr. Six deer from across the Hanford site showed very low to nondetectable levels of ^{137}Cs in the muscle.

O'Farrell et al. (1973) studied the dispersion of radioactivity in jackrabbit pellets from a known animal intrusion into 200 Area backfilled cribs. The exposed salt cake was used as a mineral lick by local species because of the lack of salt in the area. About 88% of the contaminated pellets were within 1 km of the cribs. No contaminated jackrabbit pellets were found beyond 3.2 km from the cribs, but one contaminated coyote scat was found at that distance.

Levels of ^{90}Sr (in bone), ^{137}Cs (in muscle), and $^{239,240}Pu$ (in liver) in four cottontails near the 100-N Area are shown in Table 19. See Figure 15 for sampling locations.

Table 19. Radionuclide Levels (pCi/g wet weight) in Rabbits Collected in 1989 (from Jaquish and Bryce 1990).

Levels	Radionuclide		
	^{90}Sr	^{137}Cs	$^{239,240}Pu$
Maximum[a]	160 ±3	0.15 ±0.05	0.001 ±0.001
Average[b]	80 ±91	0.04 ±0.07	0.001 ±0.001

[a]±2 sigma counting errors
[b]±2 times the standard error of the calculated mean.

These levels indicate that at some time the animals had consumed food or water contaminated with ^{90}Sr. In 1990 sampling for the Hanford Site Environmental Report, cottontails collected near the 100-N Area also showed levels of ^{90}Sr in the bones (maximum value 36.9 pCi/g, mean of 15.4 pCi/g). Cesium-137 in muscle and $^{239,240}Pu$ in liver were below detection limits (Bisping and Woodruff 1992).

6.0 ISSUES

6.1 COLUMBIA RIVER BIOTA

6.1.1 Threatened and Endangered Species

The Great Columbia River limpet (Fisherola nuttalli) and Giant Columbia spire snail (Fluminicola columbiana) are candidate species for State threatened and endangered lists. Recently, their official common names have been changed to the shortface lanx (the former limpet) and Columbia pebblesnail (the former spire snail).

Recent studies (Neitzel and Frest 1989) have revealed previously unknown populations of both species and found that the habitat required by these molluscs remains in 37 streams in Washington (including the Hanford Reach), Oregon, Idaho, and Montana. It is expected that an evaluation of the levels of contaminants in periphyton at 100-HR-3 and consideration of the status of these species will help identify any potential effects of contamination or the need for further study.

6.1.2 Pathways to Humans

As noted above, the Hanford Reach is of primary importance for sport fishing for salmon and steelhead, but sturgeon present a more probable route for the transfer of Hanford-related radionuclides to humans because of their constant residence in certain areas of the river, bottom scavenging habits, and long life (Dauble et al. 1988). In addition, anglers actively fish for whitefish and bass, and to a lesser degree, for crappie, catfish, walleye, shad, and perch (Cushing 1991). However, because salmon do not eat on their spawning runs, they do not ingest contaminated biota in the Hanford Reach and are thus not a significant pathway. Jaquish and Bryce (1989) verify this with their reported radionuclide concentrations in spawned-out salmon carcasses (see Table 5).

The results of other ongoing Hanford Site monitoring and special studies, such as Dauble et al. (1992), indicate that fish are not a pathway for Hanford-related contaminants to humans, nor have they been affected by Hanford-related contaminants. Woodruff et al. (1991) credited Columbia River fish with 28% of the negligible total dose to the maximally exposed individual (0.008 mrem from fish). While the levels of contaminants entering the river ecosystem are low, especially in comparison to the quantity and flow through the Hanford Reach, they do exist (DOE 1992a). Ongoing *Comprehensive Environmental Response Compensation and Liability Act* (CERCLA)-funded studies of contaminant levels in periphyton and caddis fly larvae in the Hanford Reach should help further evaluate if Hanford-related contamination is entering the food web.

Sediments deposited in slack water areas may have accumulated contaminants from past Hanford Site operations. It is conceivable that any macrophytes growing in these sediments could accumulate radionuclides. Studies of contaminant levels in sediments (DOE 1992b) may indicate the need for future sampling of these plants.

6.1.3 Hanford Reach Study

The U.S. Congress has authorized the Department of the Interior to study the possibility of designating the Hanford Reach as a Wild and Scenic River. The study team was formed in 1989 and is composed of representatives of the National Park Service, U.S. Fish and Wildlife Service (USFWS), and U.S. Department of Energy. More than 40 other organizations and agencies are represented on a study task force, which advises the study team on important decisions. The study report and draft environmental impact study were issued in summer of 1992. The ecosystem values of the Hanford Reach were recognized by the USFWS, which ranked the area as the second most important fish and wildlife habitat area in Washington State (USNPS 1990).

6.2 TERRESTRIAL BIOTA

6.2.1 Threatened and Endangered Species

Currently there are no federally recognized threatened or endangered plant species known to occur within the Hanford Site. Two riparian plants are candidate species for federal threatened or endangered status: persistentsepal yellowcress (Rorippa columbiae) and Columbia milkvetch (Astragalus columbianus).

Yellowcress is classified as endangered in Washington and California and threatened in Oregon (NPS 1990). Yellowcress is reported to be common along the Hanford Reach, having been observed in 1982 along both banks of the river and on islands near Rmi 345 (Rkm 555) to Rmi 362 [about 5 mi (Rkm 583) below the 100-F Area]. The plant was also found near the Vernita Bridge. Plants were always found at or near the lower edge of the vegetated zone on the river bank where vegetation cover is generally sparse, and on gently sloping gravel banks with wet silty soil beneath a layer of gravel (Sauer and Leder 1985). Milkvetch grows in silt and sand along river cobbles near the historical high water mark and is classified in Washington State as a threatened species.

Other designated plant species are located near the Hanford Site. Northern wormwood has been observed 20 km northwest of the Hanford Site, but suitable habitat exists on the Hanford Shoreline as well. Eatonella is known to occur along the Columbia River in nearby Grant County and could therefore occur along the Columbia River in or near the 100 Areas. Hoover's desert parsley is known to exist in Benton County but appears to inhabit only rocky hillsides and is thus unlikely to occur at the 100 Areas (Sackschewsky 1992).

Sackschewsky (1992) provides a comprehensive discussion of plant species either with, or being considered for, some level of protected status within the federal and state systems (Table 20).

Table 20. Hanford Site Plant Species of Concern (from Sackschewsky et al. 1992). (sheet 1 of 2)

Species	Common name	Federal[a]	State[b]
Artemisia campestris ssp. *borealis* var. *wormskioldii*	northern wormwood	C_1	E
Rorippa columbiae	Columbia yellowcress	C_2	E
Astragalus columbianus	Columbia milkvetch	C_2	T
Lomatium tuberosum	Hoover's desertparsley	C_2	T
Carex densa	dense sedge	-	S
Cryptantha interrupta	bristly cryptantha	-	S
Cryptantha leucophaea	gray cryptantha	-	S
Cyperus rivularis	shining flatsedge	-	S
Erigeron piperianus	Piper's daisy	-	S
Limosella acaulis	southern mudwort	-	S
Lindernia anagallidea	false pimpernel	-	S
Oenothera pygmaea	dwarf desertprimrose	-	S
Cuscuta denticulata	desert dodder	-	M_1
Arenaria franklinii var. *thompsonii*	Thompson's sandwort	C_{3b}	M_2
Allium robinsonii	Robinson's onion	-	M_3
Allium scillioides	squill onion	-	M_3
Artemisia lindleyana	Columbia River mugwort	-	M_3
Astragalus sclerocarpus	stalked-pod milkvetch	-	M_3
Astragalus speirocarpus	medick milkvetch	-	M_3
Astragalus succumbens	crouching milkvetch	-	M_3

Table 20. Hanford Site Plant Species of Concern (from Sackschewsky et al. 1992). (sheet 2 of 2)

Species	Common name	Federal[a]	State[b]
Balsamorhiza rosea	rosy balsamroot	-	M_3
Cirsium brevifolium	Palouse thistle	-	M_3
Pellaea glabella	smooth cliffbrake	-	M_3
Penstemon eriantherus	fuzzy beardtongue	-	M_3
Federal listings as of 2/21/90 - 55 FR 6184. State listings as of 6/90 - Washington Natural Heritage Program.			

[a]Federal Definitions

C_1 - Candidate taxa for which enough substantive information is available to support listing as threatened or endangered by the federal government.

C_2 - Candidate taxa for which there is evidence of vulnerability, but not enough data to support listing proposals at this time.

C_3 - Taxa that were once considered for listing as threatened or endangered, but are no longer candidates for listing. Sub-category (C_{3b}) includes names that, on the basis of current taxonomic understanding, do not represent distinct taxa meeting the *Endangered Species Act of 1973* definition of "species."

[b]State Definitions

E - Endangered. Taxa that are in danger of becoming extinct within the near future if factors contributing to their decline continue.

T - Threatened. Taxa that are likely to become endangered within the near future if factors contributing to their population decline or habitat degradation continue.

S - Sensitive. Taxa that are vulnerable or declining, and could become endangered or threatened without active management or removal of threats.

M_1 - Monitor Group 1. Taxa for which there is insufficient data to support listing as threatened, endangered, or sensitive.

M_2 - Monitor Group 2. Taxa with unresolved taxonomic questions.

M_3 - Monitor Group 3. Taxa that are more abundant and/or less threatened than previously assumed.

The *Endangered Species Act of 1973* requires consultation with the USFWS whenever any action is taken that may jeopardize the existence or adversely modify the habitat of any endangered species. In addition, WAC 232-12-292, *Washington State Bald Eagle Protection Rules*, request that a site management plan be prepared in consultation with Department of Wildlife personnel whenever a proposed activity would, in the opinion of the Department, adversely impact eagle habitat. Fitzner and Weiss (1991) have prepared a bald eagle site management plan to meet the intent of WAC 232-12-292.

Federal regulations (50 CFR 402) require the preparation of a biological assessment when federal actions may affect proposed threatened or endangered species. Federally listed candidate species carry no special protection. State guidelines concerning threatened and endangered species require only the preparation of a Bald Eagle Site Management Plan when actions may affect habitat important to bald eagles. There are no specific state regulations to guide the assessment or protection of other threatened or endangered species. Fitzner et al. (1991) published a biological assessment for both federal and state threatened and endangered species in relation to CERCLA characterization work.

A list of wildlife species of concern is given in Table 21. There are no reptiles or amphibians on the federal list of endangered and threatened species as currently designated for the Hanford Site.

The endangered (both federal and state) Aleutian Canada goose (*Branta canadensis leucopareia*) and peregrine falcon (*Falco peregrinus*) are rare migrants on the Hanford Reach. The Aleutian Canada goose primarily uses Willapa Bay and the Lower Columbia River areas, but banded birds have occurred in Benton County (WDOW 1989). They are expected to use the Hanford Reach only as accidentals. There is no indication to suspect that any significant levels of Hanford-related contamination are transferred to peregrines during its occasional winter visits.

Bald eagles, regular winter residents on the Hanford Reach, are classified as threatened (federal and state). Bald eagles spend several months during the winter on the Hanford Site. Their primary food is dead salmon that have spawned in the Hanford Reach and, secondarily, ducks wintering on the Hanford Reach. Salmon do not feed on their spawning run up the river and thus are not expected to have any Hanford Site-related contamination (see the aquatic section). Likewise, wintering ducks have not demonstrated any trends toward concentrating Hanford Site-related contamination (see section on known contamination). For this reason, bald eagles are not reasonably expected to acquire any Hanford Site-related contamination during their stay.

White pelicans (*Pelecanus erythrorhychos*) are state endangered. Pelicans predominantly eat live fish. Part one (Aquatics) of this report discusses evidence that fish eaten by pelicans uptake little or no contamination from past Hanford Site operations.

Table 21. Hanford Site Bird and Other Wildlife Species of Concern (from Stegen 1992). (sheet 1 of 2)

Common name	Status*	
	Federal	State
American white pelican		SE
Peregrine falcon	FE	SE
Sandhill crane		SE
Bald eagle	FT	ST
Ferruginous hawk	FC_2	ST
Common loon		SC
Northern goshawk	FC_2	SC
Swainson's hawk		SC
Golden eagle		SC
Sage grouse	FC_2	SC
Burrowing owl		SC
Western bluebird		SC
Sage thrasher		SC
Loggerhead shrike	FC_2	SC
Sage sparrow		SC
Horned grebe		SM
Western grebe		SM
Clark's grebe		SM
Great blue heron		SM
Great egret		SM
Black-crowned night-heron		SM
Turkey vulture		SM
Osprey		SM
Merlin		SM
Gyrfalcon		SM
Prairie falcon		SM
Black-necked stilt		SM
Long-billed curlew		SM
Caspian tern		SM
Arctic tern		SM
Forster's tern		SM
Black tern	FC_2	SM
Snowy owl		SM
Barred owl		SM
Ash-throated flycatcher		SM
Grasshopper sparrow		SM
Pygmy rabbit	FC_2	ST
Shortface lanx		SC
Columbia pebblesnail	FC_2	SC
Striped whipsnake		SC
Merriams shrew		SC
Pacific Western big-eared bat	FC	SC
Woodhouse's toad		SM
Night snake		SM
Sagebrush vole		SM

Table 21. Hanford Site Bird and Other Wildlife Species of Concern (from Stegen 1992). (sheet 2 of 2)

Common name	Status*	
	Federal	State
Pallid bat		SM
Northern Grasshopper mouse		SM

*FT = Federal threatened. A species which is likely to become endangered within the foreseeable future.

Federal Definitions

FE - Federal Endangered. A species in danger of extinction throughout all or a significant portion of its range.

FC_2 - Federal Candidate, category 2. More information being sought.

FC_3 - Federal Candidate, category 3. No longer considered seriously threatened.

FT - Federal Threatened. A species which is likely to become endangered within the foreseeable future.

State Definitions

SC - State Candidate. Wildlife species native to the state of Washington that the Department of Wildlife will review for possible listing as endangered, threatened, or sensitive. Candidate species are designated in Wildlife Policy 4802.

SE - State Endangered. Species native to the state of Washington that are seriously threatened with extinction throughout all or a significant portion of their ranges within the state. Endangered species are legally designated in WAC 232-12-014.

SM - State Monitor. Wildlife species native to the state of Washington that are of special interest because they: (1) Have significant popular appeal, (2) Require limited habitat during some portion of their life cycle, (3) Are indicators of environmental quality, (4) Require further field investigations to determine population status, (5) Have unresolved taxonomic problems which may bear upon status classification, (6) They may be competing with and impacting other species of concern, and (7) They were at one time classified as endangered, threatened, or sensitive. Monitor species are designated in Wildlife Policy 4803.

ST - State Threatened. Species native to the state of Washington that are likely to become endangered within the foreseeable future throughout significant portions of their range within the state without cooperative management or the removal of threats. Threatened species are legally designated in WAC 232-12-011.

6.2.2 Pathways to Humans

There is no legal sport hunting on the Hanford Site. Movement of game animals is probably toward the protected Hanford Site during hunting season instead of away from it, reducing this pathway's significance to humans. However, Hanford Site deer have been harvested off the Site by hunters (Eberhardt et al. 1982).

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 COLUMBIA RIVER BIOTA

From the studies discussed here, there is little indication of current, significant, Hanford-related contamination with regard to aquatic and terrestrial ecosystems. Most radionuclides have decayed, have been diluted, and have been washed downstream or buried by sediments over the years. The ongoing Hanford Site Environmental Monitoring program, current CERCLA studies on periphyton and caddis fly larvae in the 100-HR-3 Operable Unit, and other studies on biota, such as mule deer, appear to be adequate to detect any increases in the presence of contaminants in aquatic biota.

7.1.1 Major Species

One objective of the literature search was to identify major species in the 100 Areas. Major species are defined as those that:

- Are structurally or functionally important in the ecosystem
- Are granted protected management status
- Provide an environmental service to humans
- May be an important pathway or "indicator species" for contaminants.

A proposed list of these aquatic species based on this report is provided in Table 22.

7.1.2 Indicator Species

Bass, salmon redds, sturgeon, and periphyton may also be considered for use as indicator species to evaluate possible future contaminant release from remedial actions.

Table 22. Wildlife and Plant Species in the 100 Areas of the Hanford Site Proposed as Endpoint or "Major" Species.

Species	Reason
Periphyton	Important in ecosystem, pathway
Whitefish	Game species
Chinook salmon (redds and juveniles)	Important in ecosystem, game species
Sturgeon	Game species, important in ecosystem, pathway
Bass	Game species, pathway
Mule deer	Important in ecosystem, pathway, game species
Game birds	Pathway, game species
Coyotes	Pathway, important in ecosystem
Burrowing mice	Pathway, important in ecosystem
Harvester ants	Pathway, important in ecosystem
Honeybees	Potential pathway, service to humans
Darkling beetles	Important in ecosystem
Tumbleweed	Pathway
Cheatgrass	Important in ecosystem
Trees (esp. fruit)	Important in ecosystem, pathway
Reed canary grass	Important in ecosystem, pathway
Edible plants	Pathway, service to humans
Threatened and endangered species	Protected management status

7.2 TERRESTRIAL BIOTA

The review of currently available information, while preliminary, has revealed areas that require continued monitoring or evaluation of data from ongoing studies. It is recommended that the needs of environmental risk assessment also be examined before planning any additional work (DOE-RL 1992b). The areas of potential concern related to the terrestrial ecosystem are the following:

- Limited information on nonradioactive metals in 100 Area ecosystems is currently available. Studies to date provide no indication of any problems, nor is there reason to suspect that metals are being bioconcentrated. However, the levels of metals in 100 Area vegetation are currently being evaluated as part of CERCLA studies.

- Wild asparagus and other edible plants grow in moist sites such as the riparian area along the Hanford Reach. Some human foragers wander the south shoreline of the Columbia River looking for the plants. If plants such as wild asparagus are taking up contaminants from springs or sediments, human consumers could potentially receive a dose of unknown quantity. Asparagus samples have been collected from the 100 Area shoreline in 1991 and 1992; the results of laboratory analyses are not yet available.

- The effects of burrowing animals on retired burial grounds in the 100 Areas are not known, although impacts in the 200 and 300 Areas have been well-documented. [Burrowings in the 100 Areas has been evaluated in FY 1991 and 1992 (no sample analyses have been returned yet)].

- Swallows use mud to build nests. Sediment and spring water analysis (DOE 1992a) show little availability of contamination in mud for use by swallows. There is a limited amount of other sources of standing water or mud in the 100 Areas available to swallows away from the river.

7.2.1 Major Species

As mentioned, major species are those that are either structurally or functionally important in the ecosystem, granted protective management status, provide an environmental service to humans (e.g., game species), and/or may be a significant pathway for contaminant transfer. A proposed list of these species based on this synthesis is provided in Table 22.

Protected management status species (e.g., threatened and endangered wildlife species) have been covered thoroughly in a Biological Assessment. See Fitzner et al. (1991) for more information.

7.2.2 Indicator Species

Indicator species, which are used to monitor for the potential release of contaminants from remedial actions, should be easily collected and focused to identify specific potential problem areas. For these reasons, mice, because of their large population size, widespread occurrences, and burrowing and feeding habits; and deep-rooted vegetation (trees, tumbleweed), because of their potential to uptake deep contamination in soil or groundwater, should be used as indicator species.

8.0 REFERENCES

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APPENDIX A

AQUATIC BIOTA

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Table A.1. Algae in the Phytoplankton and Periphyton Communities of the Hanford Reach of the Columbia River (PSP&L 1982; Nietzel et al. 1982a). (sheet 1 of 4)

Chrysophyta - Diatoms
(Bacillariophyceae)

Asterionella formosa
Achnanthes lewisiana
A. lanceolata
A. minutissima
A. trinodis
A. exigua
A. linearis
A. clevei
A. flexella
A. lanceolata v. omissa
Amphora perpusilla
A. ovalis
Amphipleura sp.
Amphiprora sp.
A. pergalli
Amphipleura pellucida
Cymatopleura solea
Campylodiscus sp.
Caloneis sp.
Caloneis ventricosa v. (? subundulata)
C. amphisbaena
C. lewisii
C. hyalina
Cymbella tumida
C. naviculiformis
Cymbella sp.
C. turgid
C. sinuata
C. cistula
C. minuta
C. mexicana
C. affinis
C. prostrata
C. muelleri
C. microcephala
Cymbellonitzschia diluviana
Cyclotella spp.
C. pseudostelligera
C. kutzingiana
C. meneghiniana
C. glomerata
C. comta
C. comensis
C. bodanica
C. stelligera
C. atomas
C. ocellata
Dinobryon divergens
Denticula sp.
Diatoma sp.
D. vulgare
D. tenue v. tenue
D. hiemale v. (? mesodon)
Diploneis elliptica
D. puella
D. smithii v. dilatata
D. oculata
Epithemia spp.
E. turgida
E. sorex
Eunotia sp.
E. pectinalis
Fragilaria leptostauron v. dubia
F. vaucheriae v. vaucheriae
F. leptostauron v. leptostauron
F. construens v. venter
F. crotonensis
F. construens
F. capucina
F. leptostauron
F. virescens
Frustulia sp.
F. rhomboides
F. vulgaris
Gomphonema sp.
G. parvulum
G. subclavtum
G. olivacedides
G. truncaturn
G. ventricosum
G. olivaceum
G. olivaceum v. calcurea

Table A.1. Algae in the Phytoplankton and Periphyton Communities of the Hanford Reach of the Columbia River (PSP&L 1982; Nietzel et al. 1982a). (sheet 2 of 4)

Chrysophyta
(Bacillariophyceae)
(continued)

G. geminatum
Gyrosigma sp.
Gyrosigma spencerii
Hannaca arcus
H. arcus v. amphioxys
Hantzschia amphioxys
Melosira spp.
M. ambigua
M. granulata
M. granulata v. angust
M. italica
M. varians
M. distans v. alpigena
M. americana
Meridion sp.
M. circulare
Navicula spp.
N. seminuloides
N. minima
N. tripunctata
N. cryptocephala
N. cryptocephala v. veneta
N. mutica
N. arvensis
N. pupula
N. reinhardtii
N. pseudoreinhardtii
N. radiosa
N. viridula
N. peregrina
N. decussis
N. menisculus v. up.
N. capitata
N. cascadensis
N. bacillum
N. vitabunda
N. minuscula
N. infirmata
N. circumtexta
N. bacillum Ehr. v. bacillum
N. cincta
N. latens
N. mutica v. cohnii
N. mutica v. tropica
Nedium dubium
N. spp.
N. affine v. humerus
Nitzschia latens
N. paleacea
N. silica
N. palea
N. dissipata
N. innominata
N. perminuta
N. allansoni
N. frustulum
N. osmophila
N. obsoleta
N. linearis
N. intermissa
N. acicularis
N. amphibia
N. oregona
N. fonticola
N. bacota f. lin.
N. recta
N. angustata
N. holsatica
N. gracilis
N. stagnorum
N. lauenbergiana
N. amphioxides
N. sigmoidea
N. subacicularis
N. accomodata
N. demota
N. hungarica
N. subpunctata
N. vermicularis
N. serpenticula

Table A.1. Algae in the Phytoplankton and Periphyton Communities of the Hanford Reach of the Columbia River (PSP&L 1982; Nietzel et al. 1982a). (sheet 3 of 4)

Chrysophyta
(Bacillariophyceae)
(continued)

N. sigma v. diminuta
N. martyi sp.
Opephora sp.
Pinnularia sp.
Pinnularia subcapitata
v. paucistriata
P. borealis
Rhoicosphenia curvata
Rhopalodia gibba
Rhizosolenia eriensis
Surirella spp.
S. linearis
S. angustata
Synedra spp.
S. capitata
S. ulna
S. ulna v. chaseana
S. acus
S. delicatissima
S. rumpens
S. vaucheriae
S. parasitica
S. mazamaensis
S. cyclopum
S. pulchella
S. radians
S. socia
Stephanodiscus sp.
S. astraea
S. astrae v. min.
S. hantzschii
S. dubius
Stauroneis kriegeri
Tabellaria fenestrata
T. flocculosa

Chrysophyta - Golden or Yellow-Brown Alga
(Chrysophyceae)
Chrysococcus refescens
Codosiga
Kephyrion spirale
K. asper
K. ovale
K. gracilis
Mallomonas alpina
Mallomonas tonsurata
Ochromonas-like
Rhizochrisis

Chlorophyta - Green Algae

Ankistrodesmus falcatus
Actinastrum sp.
Asterococcus sp.
Botryococcus sp.
Crucigenia quadrata
Cosmarium sp.
Cladophora sp.
Characium ambiguum
C. sp.
Closterium acutum
C. sp.
C. gracile
Dictyosphaerium
ehrenbergianum
Eudorina sp.
E. elegans
Golenkinia sp.
Kirchneriella obesa
Lagerheimia sp.
Mougeotia
Oocystis pusilla
O. lacustria
Pandorina morum
Pediastrum boryanum
P. tetras
P. duplex

Table A.1. Algae in the Phytoplankton and Periphyton Communities of the Hanford Reach of the Columbia River (PSP&L 1982; Nietzel et al. 1982a). (sheet 4 of 4)

Chlorophyta
(continued)

Spirogyra sp.
Stigeoclonium spp.
Staurastram paradoxum
S. sp.
Scenedesmus quadicauda
S. abundans
S. acuminatus
S. longus
S. sp.
S. denticulatus
S. dimorphus
S. acutiformis
S. opoliensis
Schroederia judayi
S. setigera
Sphaerocystis schroeteri
Selanastrum minutum
S. sp.
Tetradesmus sp.
Tetraspora lacustris, lemm.
Treubaria triappendiculata
T. sp.
Ulothrix zonata
Zygnema sp.

Cyanophyta - Blue-Green Algae

Anacystis cyanea
A. montana
Anabaena sp.
Arthrospira jenneri
A. brevis
Chroococcus sp.
Calothrix parietina
Dactylococcopsis sp.
Entophysalis rivularis
Lyngbya sp.
L. limnetica
Marssoniella sp.
Oscillatoria spp.
O. planctonica
O. limnetica
O. lutea
Oedogonium sp.
Spirulina sp.
Schizothrix calcicola
S. sp.
S. fragilis
S. friesii
Tolypothrix distorta
Plectonema sp.

Rhodophyta - Red Algae

Audouinella violacea

Pyrrophyta - Dinoflagellates

Ceratium hirundinella
Cryptomonas erosa
Glenodinium sp.
Rhodomonas minuta
R. lacustris

Table A-2. Macrophytes Identified in the Hanford Reach, Columbia River.

Family	Species	Common Name
Ceratophyllaceae	*Ceratophyllum demersum*	Coontail
Cruciferae	*Rorippa calycina* *R. islandica"*	Rorippa (watercress) R. nasturtium
Cyperaceae	*Carex athrostachya* *Scirpur validus*	Carex (sedge) Bulrush
Halogaceae	*Myriophyllum spp.*	Water milfoil
Hydrocharitaceae	*Elodea canadensis*	Elodea, waterweed
Potomogetonaceae	*Juncus articulatus* *J. balticus*	Rush Rush
Lemnaceae	*Lemna spp.*	Duckweed
Jajadaceae	Potomogetan crispus P. pectinatus	Curley pondweed Curled leaf pondweed
Polygonaceae	Polygonum persicara	Buckwheat, Heartweed
Typhaceae	Typha latifolia	Cattail

Source: Watson et al. 1984.

Table A.3. Zooplankton Taxa Collected in the Hanford Reach, Columbia River 1982; Neitzel et al. 1982b). (sheet 1 of 2)

- **Coelenterata**
  - *Hydra*. spp.
- **Ectoprocta**
  - Bryozoa
    - Paludicellidae
      - *Paludicella articulata*
- **Nematoda**
- **Rotifera**
  - Brachionidae
    - *Kellicottia longispina*
    - *Keratella cochlearis*
    - *Kerratella* (? *quadrata*)
    - *Brachionus* spp.
    - *Euchlanis* spp.
    - *Kellicottia* spp.
  - Lecanidae
    - *Lecane* spp.
  - Synchaetidae
    - *Synchaeta* spp.
    - *Polyarthra* sp.
  - Testudinellidae
    - *Testudinella* spp.
- **Tardigrada**
- **Annelida**
  - Oligochaeta
  - Hirudinea
- **Arthropoda**
  - Cladocera
    - Leptodoridae
      - *Leptodora kindtii*
    - Sididae
      - *Sida crystallina*
      - *Latona* spp.
      - *Diaphanosoma* spp.
    - Daphnidae
      - *Daphnia* spp.
      - *Daphnia pulex*
      - *Daphnia middendorffiana*
      - *Ceriodaphnia* spp.
    - Bosminidae
      - *Bosmina longirostris*
    - Macrothricidae
      - *Macrothrix* spp.
      - *Dyocryptus* spp.
    - Chydoridae
      - *Pleuroxus* spp.
      - *Pleuroxus denticulatus*
      - *Alona costata*
      - *Alona quadrangalaris*
      - *Alona gutlata*
      - *Alona rectangula*

Table A.3. Zooplankton Taxa Collected in the Hanford Reach, Columbia River 1982; Neitzel et al. 1982b). (sheet 2 of 2)

Arthropoda (con't)
- *Chydorus* spp.
- Eurycercinae
  - *Eurycercus lamellatus*
- Ostracoda
- Copepoda
  - Calanoida
    - Temoridae
      - *Epischura* spp.
    - Temoridae copepodid
    - Diaptomidae
      - *Diaptomus* spp.
      - *Diaptomus ashlandi*
  - Cyclopoida
    - Cyclopidae
      - *Copepoda nauplii*
      - *Cyclops* spp.
      - *Cyclopoid copepodid*
      - *Cyclops bicuspidatus thomasi*
  - Harpacticoida

Amphipoda
- Acari

Insecta
- Collembola
- Ephemeroptera
- Trichoptera
  - Rhyacophilidae
  - Hydropsychidae
- Diptera
  - Chironomidae
  - Simuliidae
    - *Simulium* sp.

Platyhelminthes
- Turbellaria
  - *Dugesia* sp.

Protozoa
- *Vorticella* sp.

Table A.4. Benthic Macrofauna of the Hanford Reach, Columbia River 1982.

Annelida
- Oligochaeta
- Hirudinea

Arthropoda
- Hydracarina
  - Hygrobatidae
  - Hydrachnidae
- Insecta
  - Trichoptera
    - Hydropsychidae
      - *Hydropsyche cocherelli*
      - *Cheumatopsyche campyla*
      - *C. enonis*
    - Brachycentridae
      - *Brachycentrus* sp.
    - Leptoceridae
      - *Oecetis* sp.
    - Glossomatidae
    - Hydroptilidae
    - Psychomyiidae
    - Rhyacophilidae
  - Lepidoptera
    - Pyralidae
  - Hemiptera
    - Corixidae
  - Odonata
  - Collembola
  - Coleoptera
    - Elmidae
  - Ephemeroptera
    - Baetidae
  - Diptera
    - Chironomidae
    - Simuliidae
      - *Simulium* sp.
  - Plecoptera
- Crustacea
  - Amphipoda
    - *Gammarus* sp.
  - Decapoda
    - *Pacifastacus (leniusculus) trowbridgii*
- Ostracoda

Bryozoa
- *Paludicella* sp.

Table A-5. Fish Species in the Hanford Reach of the Columbia River. (from Cushing 1991)

Common Name	Scientific Name
White sturgeon	*Acipenser transmontanus*
Bridgelip sucker	*Catostomus columbianus*
Largescale sucker	*Catostomus macrocheilus*
Mountain sucker	*Catostomus platyrhynchus*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieui*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
American shad	*Alosa sapidissima*
Prickley sculpin	*Cottus asper*
Mottled sculpin	*Cottus bairdi*
Piute sculpin	*Cottus beldingi*
Reticulate sculpin	*Cottus perplexus*
Torrent sculpin	*Cottus rotheus*
Chiselmouth	*Acrocheilus alutaceus*
Carp	*Cyprinus carpio*
Peamouth	*Mylocheilus caurinus*
Northern squawfish	*Ptychocheilus oregonensis*
Longnose dace	*Rhinichthys cataractae*
Leopard dace	*Rhinichthys falcatus*
Speckled dace	*Rhinichthys osculus*
Redside shiner	*Richardsonius balteatus*
Tench	*Tinca tinca*
Burbot	*Lota lota*
Threespine stickleback	*Gasterosteus aculeatus*
Black bullhead	*Ictalurus melas*
Yellow bullhead	*Ictalurus natalis*
Brown bullhead	*Ictalurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Yellow perch	*Perca flavescens*
Walleye	*Stizostedion vitreum vitreum*
Sand roller	*Percopsis transmontana*
Pacific lamprey	*Entosphenus tridentatus*
River lamprey	*Lampetra ayresi*
Lake whitefish	*Coregonus clupeaformis*
Coho salmon	*Oncorhynchus kisutch*
Sockeye salmon	*Oncorhynchus nerka*
Chinook salmon	*Oncorhynchus tshawytscha*
Mountain whitefish	*Prosopium williamsoni*
Cutthroat trout	*Oncorhynchus clarki*
Rainbow trout (steelhead)	*Oncorhynchus mykiss*
Dolly Varden	*Salvelinus malma*

APPENDIX A

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APPENDIX B

TERRESTRIAL BIOTA

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Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
(sheet 1 of 13)

ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
ACERACEAE	*Acer saccharinum*	silver maple
AIZOACEAE	*Mollugo verticellata*	carpetweed
ALISMATACEAE	*Sagittaria cuneata*	wapato
AMARANTHACEAE	*Amaranthus albus*	white pigweed
ANACARDIACEAE	*Rhus glabra*	smooth sumac
ANACARDIACEAE	*Toxicodendron rydbergii*	poison ivy
APIACEAE	*Anthriscus scandicina*	bur chervil
APIACEAE	*Cymopteris terebinthinus*	turpentine springparsley
APIACEAE	*Lomatium canbyi*	Canby's desertparsley
APIACEAE	*Lomatium dissectum*	fernleaf desertparsley
APIACEAE	*Lomatium farinosum*	Coeur d'Alene desertparsley
APIACEAE	*Lomatium geyeri*	Geyer's desertparsley
APIACEAE	*Lomatium gormanii*	Gorman's desertparsley
APIACEAE	*Lomatium grayi*	Gray's desertparsley
APIACEAE	*Lomatium macrocarpum*	bigseed desertparsley
APIACEAE	*Lomatium triternatum*	nineleaf desertparsley
APIACEAE	*Lomatium tuberosum*	Hoover's desertparsley
APIACEAE	*Perideridia gairdneri*	Gairdner's yampah
APOCYNACEAE	*Apocynum androsaemifolium*	spreading dogbane
APOCYNACEAE	*Apocynum cannabinum*	common dogbane
APOCYNACEAE	*Apocynum sibiricum*	indian hemp
ASCLEPIADACEAE	*Asclepias fascicularis*	narrow-leaved milkweed
ASCLEPIADACEAE	*Asclepias speciosa*	showy milkweed
ASTERACEAE	*Achillea millefolium*	yarrow
ASTERACEAE	*Agoseris glauca*	pale mountain dandelion
ASTERACEAE	*Agoseris grandiflora*	showy mountain dandelion
ASTERACEAE	*Agoseris heterophylla*	annual mountain dandelion
ASTERACEAE	*Ambrosia acanthicarpa*	bur ragweed
ASTERACEAE	*Anaphalis margaritacea*	pearly everlasting
ASTERACEAE	*Antennaria dimorpha*	low pussytoes
ASTERACEAE	*Antennaria umbrinella*	umber pussytoes
ASTERACEAE	*Arctium minus*	burdock
ASTERACEAE	*Artemisia campestris* var. *wormskioldii*	northern wormwood
ASTERACEAE	*Artemisia campestris* var. *scouleriana*	Pacific sage
ASTERACEAE	*Artemisia dracunculus*	tarragon
ASTERACEAE	*Artemisia lindleyana*	Columbia River mugwort
ASTERACEAE	*Artemisia ludoviciana*	prairie sagebrush
ASTERACEAE	*Artemisia rigida*	stiff sagebrush
ASTERACEAE	*Artemisia tridentata*	big sagebrush

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992). (sheet 2 of 13)

ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
ASTERACEAE	*Artemisia tripartita*	threetip sagebrush
ASTERACEAE	*Aster campestris*	western meadow aster
ASTERACEAE	*Aster frondosus*	alkali aster
ASTERACEAE	*Aster hesperius*	western marsh aster
ASTERACEAE	*Aster occidentalis*	western mountain aster
ASTERACEAE	*Aster subspicatus*	Douglas' aster
ASTERACEAE	*Balsamorhiza careyana*	Carey's balsamroot
ASTERACEAE	*Balsamorhiza hookeri*	Hooker's balsamroot
ASTERACEAE	*Balsamorhiza rosea*	rosy balsamroot
ASTERACEAE	*Bidens cernua*	nodding beggarticks
ASTERACEAE	*Bidens frondosa*	leafy beggarticks
ASTERACEAE	*Brickellia oblongifolia*	thoroughwort
ASTERACEAE	*Centaurea diffusa*	tumble knapweed
ASTERACEAE	*Centaurea repens*	Russian knapweed
ASTERACEAE	*Centaurea solstitialis*	yellow starthistle
ASTERACEAE	*Chaenactis douglasii*	hoary falseyarrow
ASTERACEAE	*Chrysothamnus nauseosus*	gray rabbitbrush
ASTERACEAE	*Chrysothamnus viscidiflorus*	green rabbitbrush
ASTERACEAE	*Cichorium intybus*	chicory
ASTERACEAE	*Cirsium arvense*	Canada thistle
ASTERACEAE	*Cirsium brevifolium*	Palouse thistle
ASTERACEAE	*Cirsium undulatum*	gray thistle
ASTERACEAE	*Cirsium vulgare*	bull thistle
ASTERACEAE	*Conyza canadensis*	horseweed
ASTERACEAE	*Coreopsis atkinsoniana*	Columbia tickseed
ASTERACEAE	*Crepis atrabarba*	slender hawksbeard
ASTERACEAE	*Crepis barbigera*	Leiberg's hawksbeard
ASTERACEAE	*Crepis intermedia*	Gray's hawksbeard
ASTERACEAE	*Crepis modocensis*	low hawksbeard
ASTERACEAE	*Crepis occidentalis*	western hawksbeard
ASTERACEAE	*Crocidium multicaule*	spring gold
ASTERACEAE	*Erigeron corymbosus*	longleaf fleabane
ASTERACEAE	*Erigeron divergens*	spreading fleabane
ASTERACEAE	*Erigeron filifolius*	threadleaf fleabane
ASTERACEAE	*Erigeron linearis*	desert yellowdaisy
ASTERACEAE	*Erigeron piperianus*	Piper's daisy
ASTERACEAE	*Erigeron poliospermus*	cushion fleabane
ASTERACEAE	*Erigeron pumilus*	shaggy fleabane
ASTERACEAE	*Eriophyllum lanatum*	woolly sunflower
ASTERACEAE	*Filago arvensis*	field fluffweed
ASTERACEAE	*Gaillardia aristata*	blanket flower
ASTERACEAE	*Gaillardia grandiflora*	indian blanket flower
ASTERACEAE	*Gnaphalium chilense*	cottonbatting cudweed
ASTERACEAE	*Gnaphalium palustre*	lowland cudweed
ASTERACEAE	*Grindelia columbiana*	Columbia River gumweed
ASTERACEAE	*Haplopappus resinosus*	Columbia goldenweed
ASTERACEAE	*Haplopappus stenophyllus*	narrowleaf goldenweed

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
(sheet 3 of 13)

ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
ASTERACEAE	*Helenium autumnale*	sneezeweed
ASTERACEAE	*Helianthus annuus*	common sunflower
ASTERACEAE	*Helianthus cusickii*	Cusick's sunflower
ASTERACEAE	*Heterotheca villosa*	hairy golden-aster
ASTERACEAE	*Hieracium cynoglossoides*	houndstongue hawkweed
ASTERACEAE	*Hymenopappus filifolius*	Columbia cutleaf
ASTERACEAE	*Iva xanthifolia*	tall marsh-elder
ASTERACEAE	*Lactuca serriola*	prickly lettuce
ASTERACEAE	*Layia glandulosa*	white-daisy tidytips
ASTERACEAE	*Machaeranthera canescens*	hoary aster
ASTERACEAE	*Madia exigua*	little tarweed
ASTERACEAE	*Matricaria chamomilla*	wild chamomile
ASTERACEAE	*Matricaria matricarioides*	pineapple weed
ASTERACEAE	*Microseris troximoides*	false mountain dandelion
ASTERACEAE	*Senecio hydrophilus*	alkali-marsh groundsel
ASTERACEAE	*Senecio integerrimus*	lambstongue groundsel
ASTERACEAE	*Senecio pauperculus*	balsam groundsel
ASTERACEAE	*Senecio serra*	butterweed groundsel
ASTERACEAE	*Solidago canadensis*	meadow goldenrod
ASTERACEAE	*Solidago gigantea*	smooth goldenrod
ASTERACEAE	*Solidago graminifolia*	bushy goldenrod
ASTERACEAE	*Solidago missouriensis*	Missouri goldenrod
ASTERACEAE	*Solidago occidentalis*	western goldenrod
ASTERACEAE	*Sonchus asper*	prickly sowthistle
ASTERACEAE	*Sonchus uliginosus*	marsh sowthistle
ASTERACEAE	*Stephanomeria paniculata*	stiff wirelettuce
ASTERACEAE	*Stephanomeria tenuifolia*	bush wirelettuce
ASTERACEAE	*Taraxacum officinale*	dandelion
ASTERACEAE	*Tetradymia canescens*	gray horsebrush
ASTERACEAE	*Townsendia florifer*	showy Townsend-daisy
ASTERACEAE	*Tragopogon dubius*	yellow salsify
ASTERACEAE	*Xanthium strumarium*	cocklebur
BIGNONIACEAE	*Catalpa bignonioides*	catalpa
BORAGINACEAE	*Amsinckia lycopsoides*	tarweed fiddleneck
BORAGINACEAE	*Amsinckia tessellata*	devil's lettuce
BORAGINACEAE	*Cryptantha ambigua*	obscure cryptantha
BORAGINACEAE	*Cryptantha circumscissa*	matted cryptantha
BORAGINACEAE	*Cryptantha fendleri*	Fendler's cryptantha
BORAGINACEAE	*Cryptantha interrupta*	bristly cryptantha
BORAGINACEAE	*Cryptantha leucophaea*	gray cryptantha
BORAGINACEAE	*Cryptantha pterocarya*	winged cryptantha
BORAGINACEAE	*Hackelia arida*	sagebrush stickseed
BORAGINACEAE	*Hackelia diffusa*	diffuse stickseed
BORAGINACEAE	*Heliotropium curassavicum*	salt heliotrope
BORAGINACEAE	*Lappula redowskii*	western stickseed
BORAGINACEAE	*Lithospermum arvense*	corn gromwell

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
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ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
BORAGINACEAE	*Lithospermum ruderale*	western gromwell
BORAGINACEAE	*Mertensia longiflora*	small bluebells
BORAGINACEAE	*Mertensia oblongifolia*	leafy bluebells
BORAGINACEAE	*Myosotis laxa*	small forget-me-not
BORAGINACEAE	*Myosotis micrantha*	blue forget-me-not
BORAGINACEAE	*Pectocarya linearis*	winged combseed
BORAGINACEAE	*Plagiobothrys tenellus*	Pacific popcornflower
BORAGINACEAE	*Tiquilia nuttallii*	desert mat
BRASSICACEAE	*Arabidopsis thaliana*	common wallcress
BRASSICACEAE	*Arabis cusickii*	Cusick's rockcress
BRASSICACEAE	*Arabis sparsiflora*	elegant rockcress
BRASSICACEAE	*Capsella bursa-pastoris*	shepherd's purse
BRASSICACEAE	*Cardamine pensylvanica*	Pennsylvania bittercress
BRASSICACEAE	*Cardaria chalapensis*	hoarycress
BRASSICACEAE	*Cardaria draba*	whitetop
BRASSICACEAE	*Chorispora tenella*	blue mustard
BRASSICACEAE	*Descurainia pinnata*	western tansymustard
BRASSICACEAE	*Descurainia sophia*	flixweed
BRASSICACEAE	*Draba nemorosa*	woods whitlowgrass
BRASSICACEAE	*Draba verna*	spring whitlowgrass
BRASSICACEAE	*Erysimum asperum*	rough wallflower
BRASSICACEAE	*Erysimum occidentale*	pale wallflower
BRASSICACEAE	*Lepidium densiflorum*	prairie pepperweed
BRASSICACEAE	*Lepidium latifolium*	broadleaf pepperweed
BRASSICACEAE	*Lepidium perfoliatum*	clasping pepperweed
BRASSICACEAE	*Lepidium virginicum*	tall pepperweed
BRASSICACEAE	*Lesquerella douglasii*	Columbia bladderpod
BRASSICACEAE	*Phoenicaulis cheiranthoides*	daggerpod
BRASSICACEAE	*Rorippa columbiae*	Columbia yellowcress
BRASSICACEAE	*Rorippa curvisiliqua*	western yellowcress
BRASSICACEAE	*Rorippa islandica*	marsh yellowcress
BRASSICACEAE	*Rorippa nasturium-aquatica*	watercress
BRASSICACEAE	*Rorippa obtusa*	bluntleaf yellowcress
BRASSICACEAE	*Schoencrambe linifolia*	lavacress
BRASSICACEAE	*Sisymbrium altissimum*	Jim Hill's tumblemustard
BRASSICACEAE	*Sisymbrium loeselii*	Loesel's tumblemustard
BRASSICACEAE	*Streptanthella longirostris*	beaked sandcress
BRASSICACEAE	*Thelypodium laciniatum*	cutleaf ladysfoot mustard
CACTACEAE	*Opuntia fragilis*	brittle pricklypear
CACTACEAE	*Opuntia polyacantha*	starvation pricklypear
CALLITRICHACEAE	*Callitriche palustris*	water starwort
CANNABINACEAE	*Cannabis sativa*	hemp
CAPPARIDACEAE	*Cleome lutea*	yellow bee-plant
CAPRIFOLIACEAE	*Sambucus cerulea*	blue elderberry

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992). (sheet 5 of 13)

ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
CAPRIFOLIACEAE	*Symphoricarpus albus*	common snowberry
CARYOPHYLLACEAE	*Arenaria franklinii*	Franklin's sandwort
CARYOPHYLLACEAE	*Cerastium nutans*	nodding chickweed
CARYOPHYLLACEAE	*Cerastium viscosum*	sticky chickweed
CARYOPHYLLACEAE	*Cerastium vulgatum*	common chickweed
CARYOPHYLLACEAE	*Dianthus armeria*	grass pink
CARYOPHYLLACEAE	*Gypsophila paniculata*	baby's breath
CARYOPHYLLACEAE	*Holosteum umbellatum*	jagged chickweed
CARYOPHYLLACEAE	*Silene douglasii*	Douglas' catchfly
CARYOPHYLLACEAE	*Silene menziesii*	Menzies' catchfly
CARYOPHYLLACEAE	*Stellaria longipes*	longstalk starwort
CARYOPHYLLACEAE	*Stellaria nitens*	shining starwort
CERATOPHYLLACEAE	*Ceratophyllum demersum*	coontail
CHENOPODIACEAE	*Atriplex canescens*	four-wing saltbush
CHENOPODIACEAE	*Atriplex patula*	fat-hen saltbush
CHENOPODIACEAE	*Atriplex rosea*	tumbling saltbush
CHENOPODIACEAE	*Bassia hyssopifolia*	smotherweed
CHENOPODIACEAE	*Ceratoides lanata*	winterfat
CHENOPODIACEAE	*Chenopodium album*	lamb's quarters
CHENOPODIACEAE	*Chenopodium botrys*	Jerusalem oak
CHENOPODIACEAE	*Chenopodium leptophyllum*	slimleaf goosefoot
CHENOPODIACEAE	*Chenopodium rubrum*	red goosefoot
CHENOPODIACEAE	*Corispermum hyssopifolium*	common bugseed
CHENOPODIACEAE	*Grayia spinosa*	spiny hopsage
CHENOPODIACEAE	*Salsola kali*	Russian thistle
CHENOPODIACEAE	*Sarcobatus vermiculatus*	greasewood
CHENOPODIACEAE	*Suaeda occidentalis*	slender seepweed
CONVOLVULACEAE	*Convolvulus arvensis*	field bindweed
CORNACEAE	*Cornus stolonifera*	red-osier dogwood
CRASSULACEAE	*Sedum leibergii*	Leiberg's stonecrop
CUCURBITACEAE	*Echinocystis lobata*	wild cucumber
CUPRESSACEAE	*Juniperus occidentalis*	western juniper
CUPRESSACEAE	*Juniperus scopulorum*	Rocky Mountain juniper
CUSCUTACEAE	*Cuscuta denticulata*	desert dodder
CUSCUTACEAE	*Cuscuta epithymum*	common dodder
CUSCUTACEAE	*Cuscuta indecora*	plain dodder
CYPERACEAE	*Carex aperta*	Columbia sedge
CYPERACEAE	*Carex athrostachya*	slenderbeak sedge
CYPERACEAE	*Carex aurea*	golden sedge
CYPERACEAE	*Carex densa*	dense sedge
CYPERACEAE	*Carex douglasii*	Douglas' sedge
CYPERACEAE	*Carex filifolia*	threadleaf sedge
CYPERACEAE	*Carex lanuginosa*	woolly sedge
CYPERACEAE	*Carex lenticularis*	Kellogg's sedge
CYPERACEAE	*Carex microptera*	smallwinged sedge
CYPERACEAE	*Carex praegracilis*	silver sedge
CYPERACEAE	*Cyperus aristatus*	awned flatsedge

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
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ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
CYPERACEAE	*Cyperus erythrorhizos*	redroot flatsedge
CYPERACEAE	*Cyperus esculentus*	yellow flatsedge
CYPERACEAE	*Cyperus rivularis*	shining flatsedge
CYPERACEAE	*Eleocharis acicularis*	needle spikerush
CYPERACEAE	*Eleocharis ovata*	ovoid spikerush
CYPERACEAE	*Eleocharis palustris*	common spikerush
CYPERACEAE	*Scirpus acutus*	hardstem bulrush
CYPERACEAE	*Scirpus americanus*	threesquare bulrush
CYPERACEAE	*Scirpus maritimus*	alkali bulrush
CYPERACEAE	*Scirpus validus*	softstem bulrush
ELAEAGNACEAE	*Elaeagnus angustifolia*	Russian olive
EQUISETACEAE	*Equisetum arvense*	common horsetail
EQUISETACEAE	*Equisetum hyemale*	Dutch scouringrush
EQUISETACEAE	*Equisetum laevigatum*	smooth scouringrush
EQUISETACEAE	*Equisetum palustre*	marsh horsetail
EQUISETACEAE	*Equisetum variegatum*	northern scouringrush
EUPHORBIACEAE	*Eremocarpus setigerus*	doveweed
EUPHORBIACEAE	*Euphorbia glyptosperma*	corrugate-seed spurge
EUPHORBIACEAE	*Euphorbia serpyllifolia*	thymeleaf spurge
FABACEAE	*Astragalus arrectus*	Palouse milkvetch
FABACEAE	*Astragalus caricinus*	buckwheat milkvetch
FABACEAE	*Astragalus columbianus*	Columbia milkvetch
FABACEAE	*Astragalus leibergii*	Leiberg's milkvetch
FABACEAE	*Astragalus lentiginosus*	freckled milkvetch
FABACEAE	*Astragalus purshii*	woolly-pod milkvetch
FABACEAE	*Astragalus reventiformis*	Yakima milkvetch
FABACEAE	*Astragalus sclerocarpus*	stalked-pod milkvetch
FABACEAE	*Astragalus spaldingii*	Spalding's milkvetch
FABACEAE	*Astragalus speirocarpus*	medick milkvetch
FABACEAE	*Astragalus succumbens*	crouching milkvetch
FABACEAE	*Caragana arborescens*	Siberian peatree
FABACEAE	*Gleditsia triacanthos*	honey locust
FABACEAE	*Glycyrrhiza lepidota*	licorice
FABACEAE	*Lotus purshiana*	spanish clover
FABACEAE	*Lupinus laxiflorus*	spurred lupine
FABACEAE	*Lupinus lepidus*	prairie lupine
FABACEAE	*Lupinus leucophyllus*	velvet lupine
FABACEAE	*Lupinus pusillus*	low lupine
FABACEAE	*Lupinus saxosus*	rock lupine
FABACEAE	*Lupinus sericeus*	silky lupine
FABACEAE	*Lupinus sulphureus*	sulfur lupine
FABACEAE	*Lupinus wyethii*	Wyeth's lupine
FABACEAE	*Medicago lupulina*	black medick
FABACEAE	*Medicago sativa*	alfalfa
FABACEAE	*Melilotus alba*	white sweetclover
FABACEAE	*Melilotus officinalis*	yellow sweetclover
FABACEAE	*Onobrychis viciaefolia*	holyclover

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
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ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
FABACEAE	*Petalostemon ornatum*	western prairieclover
FABACEAE	*Psoralea lanceolata*	dune scurfpea
FABACEAE	*Robinia psuedo-acacia*	black locust
FABACEAE	*Swainsona salsula*	salt rattlepod
FABACEAE	*Trifolium repens*	white clover
FABACEAE	*Vicia americana*	American vetch
FABACEAE	*Vicia cracca*	bird vetch
FAGACEAE	*Juglans nigra*	black walnut
GENTIANACEAE	*Centaurium exaltatum*	western centaury
GERANIACEAE	*Erodium cicutarium*	storksbill
GERANIACEAE	*Geranium viscosissimum*	western geranium
GROSSULARIACEAE	*Ribes aureum*	golden currant
GROSSULARIACEAE	*Ribes cereum*	squaw currant
HALORAGACEAE	*Myriophyllum spicatum*	spiked water-milfoil
HYDRANGEACEAE	*Philadelphus lewisii*	mockorange
HYDROCHARITACEAE	*Elodea canadensis*	Canadian waterweed
HYDROCHARITACEAE	*Elodea nuttallii*	Nuttall's waterweed
HYDROPHYLLACEAE	*Nama densum*	purplemat
HYDROPHYLLACEAE	*Phacelia ciliata*	scorpionweed
HYDROPHYLLACEAE	*Phacelia glandulifera*	sticky scorpionweed
HYDROPHYLLACEAE	*Phacelia hastata*	whiteleaf scorpionweed
HYDROPHYLLACEAE	*Phacelia heterophylla*	virgate scorpionweed
HYDROPHYLLACEAE	*Phacelia linearis*	threadleaf scorpionweed
HYDROPHYLLACEAE	*Phacelia ramosissima*	basalt scorpionweed
HYPERICACEAE	*Hypericum formosum*	western St. John's wort
HYPERICACEAE	*Hypericum perforatum*	Klamath weed
IRIDACEAE	*Iris missouriensis*	western blue flag
JUNCACEAE	*Juncus articulatus*	jointed rush
JUNCACEAE	*Juncus balticus*	Baltic rush
JUNCACEAE	*Juncus bufonius*	toad rush
JUNCACEAE	*Juncus mertensianus*	Merten's rush
JUNCACEAE	*Juncus nevadensis*	sierra rush
JUNCACEAE	*Juncus nodosus*	tuberous rush
JUNCACEAE	*Juncus regelii*	Regel's rush
JUNCACEAE	*Juncus tenuis*	slender rush
JUNCACEAE	*Juncus torreyi*	Torrey's rush
JUNCAGINACEAE	*Triglochin palustre*	marsh arrowgrass
LAMIACEAE	*Agastache occidentalis*	western horsemint
LAMIACEAE	*Lycopus asper*	rough bugleweed
LAMIACEAE	*Marrubium vulgare*	horehound
LAMIACEAE	*Mentha arvensis*	field mint
LAMIACEAE	*Mentha spicata*	spearmint
LAMIACEAE	*Monardella odoratissima*	coyote mint
LAMIACEAE	*Nepeta cataria*	catnip
LAMIACEAE	*Physostegia parviflora*	purple dragonhead
LAMIACEAE	*Prunella vulgaris*	selfheal
LAMIACEAE	*Salvia dorrii*	grayball sage

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
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ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
LEMNACEAE	*Lemna minor*	duckweed
LILIACEAE	*Allium acuminatum*	Hooker's onion
LILIACEAE	*Allium cernuum*	nodding onion
LILIACEAE	*Allium douglasii*	Douglas' onion
LILIACEAE	*Allium macrum*	rock onion
LILIACEAE	*Allium robinsonii*	Robinson's onion
LILIACEAE	*Allium schoenoprasum*	chives
LILIACEAE	*Allium scillioides*	squill onion
LILIACEAE	*Allium tolmiei*	Tolmie's onion
LILIACEAE	*Asparagus officinalis*	asparagus
LILIACEAE	*Brodiaea douglasii*	Douglas' clusterlily
LILIACEAE	*Brodiaea howellii*	Howell's clusterlily
LILIACEAE	*Calochortus macrocarpus*	sagebrush mariposa lily
LILIACEAE	*Fritillaria pudica*	yellow bell
LILIACEAE	*Smilacina stellata*	starflower
LILIACEAE	*Yucca filamentosa*	adam's needle
LILIACEAE	*Yucca glauca*	soapweed
LILIACEAE	*Zigadenus paniculatus*	foothill deathcamas
LILIACEAE	*Zigadenus venenosus*	meadow deathcamas
LINACEAE	*Linum perenne*	wild blueflax
LOASACEAE	*Mentzelia albicaulis*	whitestem stickleaf
LOASACEAE	*Mentzelia laevicaulis*	blazingstar
LYTHRACEAE	*Rotala ramosior*	toothcup
MALVACEAE	*Sphaeralcea munroana*	Munro's globemallow
MARSILEACEAE	*Marsilea vestita*	clover fern
MORACEAE	*Morus alba*	white mulberry
NYCTAGINACEAE	*Abronia mellifera*	white sandverbena
OLEACEAE	*Fraxinus pensylvanica*	green ash
OLEACEAE	*Syringa vulgaris*	lilac
ONAGRACEAE	*Boisduvalia stricta*	stiff spikeprimrose
ONAGRACEAE	*Camissonia andina*	obscure desertprimrose
ONAGRACEAE	*Camissonia boothii*	Booth's desertprimrose
ONAGRACEAE	*Camissonia contorta*	bentpod desertprimrose
ONAGRACEAE	*Camissonia hilgardii*	Hilgard's desertprimrose
ONAGRACEAE	*Camissonia parvula*	small desertprimrose
ONAGRACEAE	*Camissonia pygmaea*	dwarf desertprimrose
ONAGRACEAE	*Epilobium angustifolium*	fireweed
ONAGRACEAE	*Epilobium glaberrimum*	smooth willowherb
ONAGRACEAE	*Epilobium minutum*	small willowherb
ONAGRACEAE	*Epilobium paniculatum*	tall willowherb
ONAGRACEAE	*Epilobium suffruticosum*	shrubby willowherb
ONAGRACEAE	*Epilobium watsonii*	Watson's willowherb
ONAGRACEAE	*Oenothera caespitosa*	rockrose
ONAGRACEAE	*Oenothera pallida*	pale eveningprimrose
ONAGRACEAE	*Oenothera strigosa*	common eveningprimrose
OROBANCHACEAE	*Orobanche corymbosa*	flattop broomrape

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
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ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
OROBANCHACEAE	*Orobanche fasciculata*	clustered broomrape
OROBANCHACEAE	*Orobanche grayana*	Gray's broomrape
PLANTAGINACEAE	*Plantago lanceolata*	English plantain
PLANTAGINACEAE	*Plantago major*	common plantain
PLANTAGINACEAE	*Plantago patagonica*	indian wheat
PLATANACEAE	*Platanus occidentalis*	sycamore
POACEAE	*Agropyron caninum*	slender wheatgrass
POACEAE	*Agropyron cristatum*	crested wheatgrass
POACEAE	*Agropyron dasytachyum*	thickspike wheatgrass
POACEAE	*Agropyron intermedium*	intermediate wheatgrass
POACEAE	*Agropyron repens*	Bermuda grass
POACEAE	*Agropyron sibericum*	Siberian wheatgrass
POACEAE	*Agropyron spicatum*	bluebunch wheatgrass
POACEAE	*Agrostis alba*	redtop bentgrass
POACEAE	*Agrostis exarata*	spike bentgrass
POACEAE	*Agrostis interrupta*	interrupted bentgrass
POACEAE	*Agrostis scabra*	ticklegrass
POACEAE	*Agrostis tenuis*	colonial bentgrass
POACEAE	*Alopecurus aequalis*	meadow foxtail
POACEAE	*Aristida longiseta*	red three-awn
POACEAE	*Avena sativa*	oat
POACEAE	*Bromus carinatus*	mountain brome
POACEAE	*Bromus inermis*	smooth brome
POACEAE	*Bromus japonicus*	Japanese brome
POACEAE	*Bromus mollis*	soft brome
POACEAE	*Bromus tectorum*	cheatgrass
POACEAE	*Cenchrus longispinus*	sandbur
POACEAE	*Dactylis glomerata*	orchardgrass
POACEAE	*Deschampsia atropurpurea*	mountain hairgrass
POACEAE	*Distichlis stricta*	alkali saltgrass
POACEAE	*Echinochloa crusgalli*	giant wildrye
POACEAE	*Elymus cinereus*	giant wildrye
POACEAE	*Elymus flavescens*	sand wildrye
POACEAE	*Elymus glaucus*	blue wildrye
POACEAE	*Eragrostis lutescens*	yellow lovegrass
POACEAE	*Eragrostis pectinacea*	purple lovegrass
POACEAE	*Festuca arundinacea*	tall fescue
POACEAE	*Festuca bromoides*	barren sixweeks
POACEAE	*Festuca idahoensis*	Idaho fescue
POACEAE	*Festuca microstachys*	small sixweeks
POACEAE	*Festuca octoflora*	slender sixweeks
POACEAE	*Festuca ovina*	sheep fescue
POACEAE	*Hierochloe odorata*	vanilla grass
POACEAE	*Hordeum brachyantherum*	meadow barley
POACEAE	*Hordeum glaucum*	seagreen barley
POACEAE	*Hordeum jubatum*	squirreltail barley
POACEAE	*Koeleria cristata*	prairie junegrass

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
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ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
POACEAE	*Leersia oryzoides*	cutgrass
POACEAE	*Melica spectabilis*	showy oniongrass
POACEAE	*Muhlenbergia asperifolia*	alkali muhly
POACEAE	*Oryzopsis hymenoides*	indian ricegrass
POACEAE	*Panicum capillare*	common witchgrass
POACEAE	*Panicum miliaceum*	broomcorn millet
POACEAE	*Panicum occidentale*	western witchgrass
POACEAE	*Paspalum distichum*	knotgrass
POACEAE	*Phalaris arundinacea*	reed canarygrass
POACEAE	*Phleum pratense*	timothy
POACEAE	*Phragmites communis*	common reed
POACEAE	*Poa annua*	annual bluegrass
POACEAE	*Poa bulbosa*	bulbous bluegrass
POACEAE	*Poa compressa*	Canada bluegrass
POACEAE	*Poa cusickii*	Cusick's bluegrass
POACEAE	*Poa juncifolia*	alkali bluegrass
POACEAE	*Poa nevadensis*	Nevada bluegrass
POACEAE	*Poa palustris*	fowl bluegrass
POACEAE	*Poa pratensis*	Kentucky bluegrass
POACEAE	*Poa sandbergii*	Sandberg's bluegrass
POACEAE	*Poa scabrella*	pine bluegrass
POACEAE	*Polypogon monspeliensis*	rabbitfoot grass
POACEAE	*Sclerochloa dura*	hardgrass
POACEAE	*Secale cereale*	rye
POACEAE	*Setaria lutescens*	bristly foxtail
POACEAE	*Sitanion hystrix*	bottlebrush squirreltail
POACEAE	*Sporobolus cryptandrus*	sand dropseed
POACEAE	*Stipa comata*	needle-and-thread grass
POACEAE	*Stipa thurberiana*	Thurber's needlegrass
POACEAE	*Triticum aestivum*	wheat
POLEMONIACEAE	*Collomia grandiflora*	largeflowered collomia
POLEMONIACEAE	*Collomia linearis*	narrowleaf collomia
POLEMONIACEAE	*Eriastrum sparsiflorum*	few-flowered eriastrum
POLEMONIACEAE	*Gilia leptomeria*	Great Basin gilia
POLEMONIACEAE	*Gilia minutiflora*	smallflower gilia
POLEMONIACEAE	*Gilia sinuata*	shy gilia
POLEMONIACEAE	*Leptodactylon pungens*	prickly phlox
POLEMONIACEAE	*Linanthus pharnaceoides*	threadleaf linanthus
POLEMONIACEAE	*Microsteris gracilis*	pink microsteris
POLEMONIACEAE	*Navarretia intertexta*	pincushion plant
POLEMONIACEAE	*Phlox hoodii*	Hood's phlox
POLEMONIACEAE	*Phlox longifolia*	longleaf phlox
POLEMONIACEAE	*Phlox speciosa*	showy phlox
POLEMONIACEAE	*Polemonium micranthum*	annual Jacob's ladder
POLYGONACEAE	*Eriogonum compositum*	northern buckwheat
POLYGONACEAE	*Eriogonum elatum*	tall buckwheat

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992). (sheet 11 of 13)

ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
POLYGONACEAE	*Eriogonum heracleoides*	parnsipflower buckwheat
POLYGONACEAE	*Eriogonum microthecum*	slender buckwheat
POLYGONACEAE	*Eriogonum niveum*	snow buckwheat
POLYGONACEAE	*Eriogonum sphaerocephalum*	rock buckwheat
POLYGONACEAE	*Eriogonum strictum*	strict buckwheat
POLYGONACEAE	*Eriogonum thymoides*	thymeleaf buckwheat
POLYGONACEAE	*Eriogonum vimineum*	broom buckwheat
POLYGONACEAE	*Oxytheca dendroides*	false buckwheat
POLYGONACEAE	*Polygonum aviculare*	doorweed
POLYGONACEAE	*Polygonum coccineum*	water smartweed
POLYGONACEAE	*Polygonum convolvulus*	climbing bindweed
POLYGONACEAE	*Polygonum lapathifolium*	willow weed
POLYGONACEAE	*Polygonum majus*	wiry knotweed
POLYGONACEAE	*Polygonum persicaria*	heartweed
POLYGONACEAE	*Polygonum ramosissimum*	busy knotweed
POLYGONACEAE	*Rumex crispus*	curly dock
POLYGONACEAE	*Rumex salicifolius*	willow dock
POLYGONACEAE	*Rumex venosus*	winged dock
POLYPODIACEAE	*Adiantum pedatum*	maiden-hair fern
POLYPODIACEAE	*Pellaea glabella*	smooth cliffbrake
POLYPODIACEAE	*Pteridium aquilinum*	bracken fern
POLYPODIACEAE	*Woodsia oregana*	woodsia
PORTULACACEAE	*Lewisia rediviva*	bitterroot
PORTULACACEAE	*Montia cordifolia*	broadleaf springbeauty
PORTULACACEAE	*Montia linearis*	indian lettuce
PORTULACACEAE	*Montia perfoliata*	miner's lettuce
PORTULACACEAE	*Portulaca oleracea*	common purslane
PORTULACACEAE	*Talinum spinescens*	spiny flameflower
POTAMOGETONACEAE	*Potamogeton berchtoldii*	Berchtold's pondweed
POTAMOGETONACEAE	*Potamogeton crispus*	curled pondweed
POTAMOGETONACEAE	*Potamogeton filiformis*	slender pondweed
POTAMOGETONACEAE	*Potamogeton foliosus*	leafy pondweed
POTAMOGETONACEAE	*Potamogeton pectinatus*	fennel-leaf pondweed
PRIMULACEAE	*Dodecatheon cusickii*	Cusick's shootingstar
PRIMULACEAE	*Lysimachia ciliata*	fringed loosestrife
RANUNCULACEAE	*Aquilegia formosa*	red columbine
RANUNCULACEAE	*Clematis ligusticifolia*	western virginsbower
RANUNCULACEAE	*Delphinium multiplex*	Kittitas larkspur
RANUNCULACEAE	*Delphinium nuttallianum*	upland larkspur
RANUNCULACEAE	*Myosurus aristatus*	sedge mousetail
RANUNCULACEAE	*Ranunculus cymbalaria*	shore buttercup
RANUNCULACEAE	*Ranunculus flammula*	creeping buttercup
RANUNCULACEAE	*Ranunculus glaberrimus*	sagebrush buttercup
RANUNCULACEAE	*Ranunculus sceleratus*	celeryleaf buttercup
RANUNCULACEAE	*Ranunculus subrigidus*	stiffleaf buttercup
RANUNCULACEAE	*Ranunculus testiculatus*	bur buttercup
ROSACEAE	*Amelanchier alnifolia*	western serviceberry

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
(sheet 12 of 13)

ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
ROSACEAE	*Crataegus douglasii*	black hawthorn
ROSACEAE	*Geum macrophyllum*	Oregon avens
ROSACEAE	*Geum triflorum*	old man's whiskers
ROSACEAE	*Malus pumila*	apple
ROSACEAE	*Physocarpus malvaceus*	ninebark
ROSACEAE	*Potentilla anserina*	common silverweed
ROSACEAE	*Potentilla arguta*	tall cinquefoil
ROSACEAE	*Potentilla biennis*	biennial cinquefoil
ROSACEAE	*Potentilla gracilis*	slender cinquefoil
ROSACEAE	*Potentilla norvegica*	Norwegian cinquefoil
ROSACEAE	*Potentilla paradoxa*	bushy cinquefoil
ROSACEAE	*Potentilla rivalis*	brook cinquefoil
ROSACEAE	*Prunus armeniaca*	apricot
ROSACEAE	*Prunus avium*	sweet cherry
ROSACEAE	*Prunus emarginata*	bitter cherry
ROSACEAE	*Prunus persica*	peach
ROSACEAE	*Prunus virginiana*	chokecherry
ROSACEAE	*Purshia tridentata*	antelope bitterbrush
ROSACEAE	*Pyrus communis*	pear
ROSACEAE	*Rosa woodsii*	Wood's rose
ROSACEAE	*Rubus discolor*	Himalayan blackberry
RUBIACEAE	*Galium aparine*	cleavers
RUBIACEAE	*Galium multiflorum*	shrubby bedstraw
RUPPIACEAE	*Ruppia maritima*	ditch grass
SALICACEAE	*Populus alba*	silver poplar
SALICACEAE	*Populus deltoides*	plain's cottonwood
SALICACEAE	*Populus nigra*	Lombardy poplar
SALICACEAE	*Populus tremuloides*	quaking aspen
SALICACEAE	*Populus trichocarpa*	black cottonwood
SALICACEAE	*Salix amygdaloides*	peachleaf willow
SALICACEAE	*Salix babylonica*	weeping willow
SALICACEAE	*Salix bebbiana*	Bebb's willow
SALICACEAE	*Salix exigua*	coyote willow
SALICACEAE	*Salix fragilis*	crack willow
SALICACEAE	*Salix lasiandra*	whiplash willow
SALICACEAE	*Salix lasiolepis*	arroyo willow
SALICACEAE	*Salix scouleriana*	Scouler's willow
SANTALACEAE	*Comandra umbellata*	bastard toadflax
SAXIFRAGACEAE	*Heuchera cylindrica*	lava alumroot
SAXIFRAGACEAE	*Lithophragma bulbifera*	bulbiferous fringecup
SAXIFRAGACEAE	*Lithophragma glabra*	smooth fringecup
SAXIFRAGACEAE	*Lithophragma parviflora*	smallflower fringecup
SAXIFRAGACEAE	*Saxifraga integrifolia*	swamp saxifrage
SAXIFRAGACEAE	*Saxifraga oregana*	bog saxifrage
SCROPHULARIACEAE	*Castilleja exilis*	alkali paintbrush
SCROPHULARIACEAE	*Castilleja thompsonii*	Thompson's paintbrush
SCROPHULARIACEAE	*Collinsia parviflora*	small blue-eyed Mary

Table B-1. Vascular Taxa of the Hanford Site (from Sackschewsky et al. 1992).
(sheet 13 of 13)

ALPHABETICAL LISTING BY FAMILY

Family	Species	Common name
SCROPHULARIACEAE	*Collinsia sparsiflora*	sparse blue-eyed Mary
SCROPHULARIACEAE	*Gratiola neglecta*	American hedge-hyssop
SCROPHULARIACEAE	*Limosella aquatica*	southern mudwort
SCROPHULARIACEAE	*Linaria dalmatica*	Dalmatian toadflax
SCROPHULARIACEAE	*Lindernia anagallidea*	false pimpernel
SCROPHULARIACEAE	*Mazus japonicus*	Japanese mazus
SCROPHULARIACEAE	*Mimetanthe pilosa*	downy monkeyflower
SCROPHULARIACEAE	*Mimulus floribundus*	purplestem monkeyflower
SCROPHULARIACEAE	*Mimulus guttatus*	yellow monkeyflower
SCROPHULARIACEAE	*Penstemon acuminatus*	sand beardtongue
SCROPHULARIACEAE	*Penstemon eriantherus*	fuzzy beardtongue
SCROPHULARIACEAE	*Penstemon gairdneri*	Gairdner's beardtongue
SCROPHULARIACEAE	*Penstemon glandulosus*	stickystem beardtongue
SCROPHULARIACEAE	*Penstemon richardsonii*	basalt beardtongue
SCROPHULARIACEAE	*Penstemon speciosus*	showy beardtongue
SCROPHULARIACEAE	*Scrophularia lanceolata*	lanceleaf figwort
SCROPHULARIACEAE	*Verbascum thapsus*	common mullein
SCROPHULARIACEAE	*Veronica americana*	brooklime
SCROPHULARIACEAE	*Veronica anagallis-aquatica*	water speedwell
SCROPHULARIACEAE	*Veronica peregina*	purslane speedwell
SIMAROUBACEAE	*Ailanthus altissima*	tree-of-heaven
SOLANACEAE	*Lycium halimifolium*	matrimony vine
SOLANACEAE	*Nicotiana attenuata*	coyote tobacco
SOLANACEAE	*Solanum dulcamara*	bittersweet
SOLANACEAE	*Solanum nigrum*	black nightshade
SOLANACEAE	*Solanum triflorum*	cutleaf nightshade
TAMARICACEAE	*Tamarix parviflora*	tamarisk
TAXACEAE	*Taxus cuspidata*	Japanese yew
TYPHACEAE	*Typha angustifolia*	lesser cattail
TYPHACEAE	*Typha latifolia*	common cattail
ULMACEAE	*Ulmus americana*	American elm
ULMACEAE	*Ulmus pumila*	Siberian elm
URTICACEAE	*Urtica dioica*	stinging nettle
VALERIANACEAE	*Plectritis macrocera*	white cupseed
VERBENACEAE	*Verbena bracteata*	bracted verbena
VERBENACEAE	*Verbena hastata*	blue verbena
VIOLACEAE	*Viola adunca*	early blue violet
VIOLACEAE	*Viola trinervata*	sagebrush violet
VITACEAE	*Parthenocissus quinquefolia*	Virginia creeper
ZANNICHELLIACEAE	*Zannichellia palustris*	horned pondweed
ZYGOPHYLLACEAE	*Tribulus terrestris*	puncture vine

Table B-2. List of Mammals Occurring on the Hanford Site (from Cushing 1991).

Common Name	Scientific Name
Merriam's shrew	*Sorex merriami*
Vagrant shrew	*Sorex vagrans*
Little brown bat	*Myotis lucifugus*
Silver-haired bat	*Lasionycteris noctivagans*
California brown bat	*Myotis californicus*
Yuma brown bat	*Myotis yumanensis*
Pallid bat	*Antrozous pallidus*
Hoary bat	*Lasiurus cinereus*
Raccoon	*Procyon lotor*
Mink	*Mustela vison*
Long-tailed weasel	*Mustela frenata*
Short-tailed weasel	*Mustela ermineu*
Badger	*Taxidea taxis*
Striped skunk	*Mephitis mephitis*
Coyote	*Canis latrans*
Bobcat	*Lynx rufus*
Least chipmunk	*Eutamias minimus*
Yellow-bellied marmot	*Marmota flaviventris*
Townsend's ground squirrel	*Spermophilus townsendii*
Northern pocket gopher	*Thomomys talpoides*
Great Basin pocket mouse	*Perognathus parvus*
Beaver	*Castor canadensis*
Western harvest mouse	*Reithrodontomys megalotis*
Deer mouse	*Peromyscus maniculatus*
Northern grasshopper mouse	*Onychomys leucogaster*
Montane meadow mouse	*Microtus montanus*
Bushy-tailed woodrat	*Neotoma cinerea*
Sagebrush vole	*Lagurus curtatus*
Muskrat	*Ondatra zibethicus*
House mouse	*Mus musculus*
Norway rat	*Rattus norvegicus*
Porcupine	*Erethizon dorsatum*
Black-tailed jackrabbit	*Lepus californicus*
White-tailed jackrabbit	*Lepus townsendi*
Nuttall's cottontail rabbit	*Sylvilagus nuttallii*
Mule deer	*Odocoileus hemionus*
White-tailed deer	*Odocoileus virginianus*
Elk	*Cervus elaphus*
Otter	*Lutra canadensis*

Table B-3. Status of Birds of the Hanford Site, Washington.
(sheet 1 of 11)

Family	Common name	Genus species	Status*
Gaviidae			
	Pacific loon	*Gavia pacifica*	Rw
	common loon	*Gavia immer*	Rw
Podicipedidae			
	pied-billed grebe	*Podilymbus podiceps*	Cr
	horned grebe	*Podiceps auritus*	Uw
	eared grebe	*Podiceps nigricollis*	Um
	western grebe	*Aechmophorus occidentalis*	Ur
	Clark's grebe	*Aechmophorus clarkii*	Rm
Pelecanidae			
	American white pelican	*Pelecanus erythrorhynchos*	Ur
Phalacrocoracidae			
	double-crested cormorant	*Phalacrocorax auritus*	Ur
Ardeidae			
	American bittern	*Botaurus lentiginosus*	Rs
	great blue heron	*Ardea herodias*	Cr
	snowy egret	*Egretta thula*	Rm
	great egret	*Casmerodius albus*	Rm
	black-crowned night-heron	*Nycticorax nycticorax*	Ur
Anatidae			
	tundra swan	*Cygnus columbianus*	Rw
	trumpeter swan	*Cygnus buccinator*	Am
	greater white-fronted goose	*Anser albifrons*	Rm
	snow goose	*Chen caerulescens*	Rw
	Canada goose	*Branta canadensis*	Cr
	brant	*Branta bernicla*	Am
	green-winged teal	*Anas crecca*	Us

*Abundance:
- C - common--often seen or heard in appropriate habitat
- U - uncommon--usually present but not always seen or heard
- R - rare--present in appropriate habitats only in small numbers; seldom seen or heard
- A - accidental--appeared once or twice, but well out of normal range.

Seasonal occurrence:
- r - resident--present all year but abundance may vary seasonally
- s - summer visitor (includes spring and fall)
- w - winter visitor (includes spring and fall)
- m - migrant.

Table B-3. Status of Birds of the Hanford Site, Washington.
(sheet 2 of 11)

Family	Common name	Genus species	Status*
Anatidae (continued)			
	mallard	*Anas platyrhynchos*	Cr
	northern pintail	*Anas acuta*	Cw
	blue-winged teal	*Anas discors*	Rm
	cinnamon teal	*Anas cyanoptera*	Us
	northern shoveler	*Anas clypeata*	Cr
	gadwall	*Anas strepera*	Uw
	eurasian wigeon	*Anas penelope*	Rw
	American wigeon	*Anas americana*	Cw
	canvasback	*Aythya valisineria*	Uw
	redhead	*Aythya americana*	Cw
	ring-necked duck	*Aythya collaris*	Uw
	lesser scaup	*Aythya affinis*	Uw
	greater scaup	*Aythya marila*	Rw
	oldsquaw	*Clangula hyemalis*	Rw
	common goldeneye	*Bucephala clangula*	Uw
	Barrow's goldeneye	*Bucephala islandica*	Rw
	bufflehead	*Bucephala albeola*	Cw
	hooded merganser	*Lophodytes cucullatus*	Rw
	common merganser	*Mergus merganser*	Cw
	red-breasted merganser	*Mergus serrator*	Aw
	ruddy duck	*Oxyura jamaicensis*	Ur
Cathartidae			
	turkey vulture	*Cathartes aura*	Am
Accipitridae			
	osprey	*Pandion haliaetus*	Um
	bald eagle	*Haliaeetus leucocephalus*	Uw

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- A - accidental--appeared once or twice, but well out of normal range.

Seasonal occurrence:
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Table B-3. Status of Birds of the Hanford Site, Washington. (sheet 3 of 11)

Family	Common name	Genus species	Status*
Accipitridae (continued)			
	northern harrier	*Circus cyaneus*	Ur
	sharp-shinned hawk	*Accipiter striatus*	Rw
	Cooper's hawk	*Accipiter cooperii*	Rw
	northern goshawk	*Accipiter gentilis*	Rw
	Swainson's hawk	*Buteo swainsoni*	Us
	red-tailed hawk	*Buteo jamaicensis*	Ur
	ferruginous hawk	*Buteo regalis*	Rs
	rough-legged hawk	*Buteo lagopus*	Rw
	golden eagle	*Aquila chrysaetos*	Um
Falconidae			
	American kestrel	*Falco sparverius*	Ur
	merlin	*Falco columbarius*	Rm
	peregrine falcon	*Falco peregrinus*	Am
	gyrfalcon	*Falco rusticolus*	Aw
	prairie falcon	*Falco mexicanus*	Ur
Phasianidae			
	gray partridge	*Perdix perdix*	Rr
	chukar	*Alectoris chukar*	Ur
	ring-necked pheasant	*Phasianus colchicus*	Ur
	sage grouse	*Centrocercus urophasianus*	Rr
	northern bobwhite	*Colinus virginianus*	Rr
	scaled quail	*Callipepla squamata*	Rr
	California quail	*Callipepla californica*	Ur
Rallidae			
	Virginia rail	*Rallus limicola*	Rr
	sora	*Porzana carolina*	Rs

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- A - accidental--appeared once or twice, but well out of normal range.

Seasonal occurrence:
- r - resident--present all year but abundance may vary seasonally
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- w - winter visitor (includes spring and fall)
- m - migrant.

Table B-3. Status of Birds of the Hanford Site, Washington.
(sheet 4 of 11)

Family	Common name	Genus species	Status*
Rallidae (continued)			
	American coot	*Fulica americana*	Cr
Gruidae			
	sandhill crane	*Grus canadensis*	Um
Charadriidae			
	blackbellied plover	*Pluvialis squatarola*	Am
	killdeer	*Charadrius vociferus*	Cr
	mountain plover	*Charadrius montanus*	Am
Recurvirostridae			
	American avocet	*Recurvirostra americana*	Us
	black-necked stilt	*Himantopus mexicanus*	A
Scolopacidae			
	greater yellowlegs	*Tringa melanoleuca*	Um
	lesser yellowlegs	*Tringa flavipes*	Um
	solitary sandpiper	*Tringa solitaria*	Rm
	spotted sandpiper	*Actitis macularia*	Um
	long-billed curlew	*Numenius americanus*	Cs
	marbled godwit	*Limosa fedoa*	Am
	sanderling	*Calidris alba*	Um
	semipalmated sandpiper	*Calidris pusilla*	Rm
	western sandpiper	*Calidris mauri*	Cm
	least sandpiper	*Calidris minutilla*	Cm
	Baird's sandpiper	*Calidris bairdii*	Rm
	pectoral sandpiper	*Calidris melanotos*	Um
	sharp-tailed sandpiper	*Calidris acuminata*	Am
	dunlin	*Calidris alpina*	Um
	long-billed dowitcher	*Limnodromus scolopaceus*	Cm
	common snipe	*Gallinago gallinago*	Rr

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Table B-3. Status of Birds of the Hanford Site, Washington.
(sheet 5 of 11)

Family	Common name	Genus species	Status*
Scolopacidae (continued)			
	Wilson's phalarope	*Phalaropus tricolor*	Us
	red-necked phalarope	*Phalaropus lobatus*	Um
	red phalarope	*Phalaropus fulicaria*	Am
Laridae			
	parasitic jaeger	*Stercorarius parasiticus*	Am
	long-tailed jaeger	*Stercorarius longicaudus*	Am
	Franklin's gull	*Larus pipixcan*	Rm
	Bonaparte's gull	*Larus philadelphia*	Um
	ring-billed gull	*Larus delawarensis*	Cr
	California gull	*Larus californicus*	Cr
	herring gull	*Larus argentatus*	Aw
	glaucous-winged gull	*Larus glaucescens*	Uw
	Sabine's gull	*Xema sabini*	Rm
	caspian tern	*Sterna caspia*	Rs
	common tern	*Sterna hirundo*	Rm
	Forster's tern	*Sterna forsteri*	Us
	arctic tern	*Sterna paradisaea*	Am
	black tern	*Chlidonias niger*	Rm
Columbidae			
	rock dove	*Columba livia*	Cr
	band-tailed pigeon	*Columba fasciata*	Am
	mourning dove	*Zenaida macroura*	Cs
Tytonidae			
	barn owl	*Tyto alba*	Ur
Strigidae			
	flammulated owl	*Otus flammeolus*	Am

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Seasonal occurrence:

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Table B-3. Status of Birds of the Hanford Site, Washington. (sheet 6 of 11)

Family	Common name	Genus species	Status*
Strigidae (continued)			
	western screech-owl	*Otus kennicottii*	Am
	great horned owl	*Bubo virginianus*	Ur
	barred owl	*Strix varia*	Am
	snowy owl	*Nyctea scandiaca*	Rw
	burrowing owl	*Athene cunicularia*	Us
	long-eared owl	*Asio otus*	Ur
	short-eared owl	*Asio flammeus*	Ur
	northern saw-whet owl	*Aegolius acadicus*	Am
Caprimulgidae			
	common nighthawk	*Chordeiles minor*	Cs
	common poorwill	*Phalaenoptilus nuttallii*	Am
Apodidae			
	white-throated swift	*Aeronautes saxatalis*	Rs
Trochilidae			
	black-chinned hummingbird	*Archilochus alexandri*	Am
	calliope hummingbird	*Stellula calliope*	Um
	rufous hummingbird	*Selasphorus rufus*	Um
Alcedinidae			
	belted kingfisher	*Ceryle alcyon*	Ur
Picidae			
	Lewis' woodpecker	*Melanerpes lewis*	Rm
	downy woodpecker	*Picoides pubescens*	Rw
	hairy woodpecker	*Picoides villosus*	Rw
	northern flicker	*Colaptes auratus*	Ur
Tyrannidae			
	olive-sided flycatcher	*Contopus borealis*	Rm

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R - rare--present in appropriate habitats only in small numbers; seldom seen or heard
A - accidental--appeared once or twice, but well out of normal range.

Seasonal occurrence:

r - resident--present all year but abundance may vary seasonally
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w - winter visitor (includes spring and fall)
m - migrant.

Table B-3. Status of Birds of the Hanford Site, Washington.
(sheet 7 of 11)

Family	Common name	Genus species	Status*
Tyrannidae (continued)			
	western wood-pewee	*Contopus sordidulus*	Um
	willow flycatcher	*Empidonax traillii*	Rm
	dusky flycatcher	*Empidonax oberholseri*	Rm
	cordilleran flycatcher	*Empidonax occidentalis*	Um
	Say's phoebe	*Sayornis saya*	Us
	black phoebe	*Sayornis nigricans*	Am
	ash-throated flycatcher	*Myiarchus cinerascens*	Rs
	western kingbird	*Tyrannus verticalis*	Cs
	eastern kingbird	*Tyrannus tyrannus*	Us
Alaudidae			
	horned lark	*Eremophila alpestris*	Cr
Hirundinidae			
	tree swallow	*Tachycineta bicolor*	Um
	violet-green swallow	*Tachycineta thalassina*	Rm
	northern rough-winged swallow	*Stelgidopteryx serripennis*	Us
	bank swallow	*Riparia riparia*	Us
	cliff swallow	*Hirundo pyrrhonota*	Cs
	barn swallow	*Hirundo rustica*	Cs
Corvidae			
	Steller's jay	*Cyanocitta stelleri*	Rw
	scrub jay	*Aphelocoma coerulescens*	Am
	Clark's nutcracker	*Nucifraga columbiana*	Rm
	black-billed magpie	*Pica pica*	Cr
	American crow	*Corvus brachyrhynchos*	Ur
	common raven	*Corvus corax*	Cr

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Table B-3. Status of Birds of the Hanford Site, Washington.
(sheet 8 of 11)

Family	Common name	Genus species	Status*
Paridae			
	black-capped chickadee	*Parus atricapillus*	Um
Sittidae			
	red-breasted nuthatch	*Sitta canadensis*	Ur
Certhiidae			
	brown creeper	*Certhia americana*	A
Troglodytidae			
	rock wren	*Salpinctes obsoletus*	Us
	canyon wren	*Catherpes mexicanus*	Rs
	Bewick's wren	*Thryomanes bewickii*	Rs
	house wren	*Troglodytes aedon*	Rs
	winter wren	*Troglodytes troglodytes*	Rw
	marsh wren	*Cistothorus palustris*	Ur
Muscicapidae			
	golden-crowned kinglet	*Regulus satrapa*	Uw
	ruby-crowned kinglet	*Regulus calendula*	Uw
	western bluebird	*Sialia mexicana*	Rm
	mountain bluebird	*Sialia currucoides*	Rm
	Townsend's solitaire	*Myadestes townsendi*	Rw
	Swainson's thrush	*Catharus ustulatus*	Rm
	hermit thrush	*Catharus guttatus*	Uw
	American robin	*Turdus migratorius*	Cr
	varied thrush	*Ixoreus naevius*	Rw
Mimidae			
	gray catbird	*Dumetella carolinensis*	Am
	northern mockingbird	*Mimus polyglottos*	Am
	sage thrasher	*Oreoscoptes montanus*	Rs
Motacillidae			
	American pipit	*Anthus rubescens*	Um

*Abundance:
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- U - uncommon--usually present but not always seen or heard
- R - rare--present in appropriate habitats only in small numbers; seldom seen or heard
- A - accidental--appeared once or twice, but well out of normal range.

Seasonal occurrence:
- r - resident--present all year but abundance may vary seasonally
- s - summer visitor (includes spring and fall)
- w - winter visitor (includes spring and fall)
- m - migrant.

Table B-3. Status of Birds of the Hanford Site, Washington. (sheet 9 of 11)

Family	Common name	Genus species	Status*
Bombycillidae			
	Bohemian waxwing	*Bombycilla garrulus*	Rw
	cedar waxwing	*Bombycilla cedrorum*	Uw
Laniidae			
	northern shrike	*Lanius excubitor*	Uw
	loggerhead shrike	*Lanius ludovicianus*	Us
Sturnidae			
	European starling	*Sturnus vulgaris*	Cr
Vireonidae			
	solitary vireo	*Vireo solitarius*	Um
	Hutton's vireo	*Vireo huttoni*	Am
	warbling vireo	*Vireo gilvus*	Um
	Philadelphia vireo	*Vireo philadelphicus*	Am
	red-eyed vireo	*Vireo olivaceus*	Um
Emberizidae			
	Tennessee warbler	*Vermivora peregrina*	Am
	orange-crowned warbler	*Vermivora celata*	Um
	Nashville warbler	*Vermivora ruficapilla*	Rm
	yellow warbler	*Dendroica petechia*	Us
	yellow-rumped warbler	*Dendroica coronata*	Cw
	Townsend's warbler	*Dendroica townsendi*	Um
	palm warbler	*Dendroica palmarum*	Am
	American redstart	*Setophaga ruticilla*	Am
	MacGillivray's warbler	*Oporornis tolmiei*	Um
	common yellowthroat	*Geothlypis trichas*	Rm
	Wilson's warbler	*Wilsonia pusilla*	Um
	yellow-breasted chat	*Icteria virens*	Us

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Table B-3. Status of Birds of the Hanford Site, Washington.
(sheet 10 of 11)

Family	Common name	Genus species	Status*
Emberizidae (continued)			
	western tanager	*Piranga ludoviciana*	Um
	rose-breasted grosbeak	*Pheucticus ludovicianus*	Am
	black-headed grosbeak	*Pheucticus melanocephalus*	Rs
	lazuli bunting	*Passerina amoena*	Rs
	rufous-sided towhee	*Pipilo erythrophthalmus*	Uw
	American tree sparrow	*Spizella arborea*	Rw
	chipping sparrow	*Spizella passerina*	Rm
	Brewer's sparrow	*Spizella breweri*	Rr
	vesper sparrow	*Pooecetes gramineus*	Rm
	lark sparrow	*Chondestes grammacus*	Rs
	sage sparrow	*Amphispiza belli*	Us
	savannah sparrow	*Passerculus sandwichensis*	Us
	grasshopper sparrow	*Ammodramus savannarum*	Us
	fox sparrow	*Passerella iliaca*	Rm
	song sparrow	*Melospiza melodia*	Ur
	Lincoln's sparrow	*Melospiza lincolnii*	Rm
	swamp sparrow	*Melospiza georgiana*	Am
	golden-crowned sparrow	*Zonotrichia atricapilla*	Rm
	white-crowned sparrow	*Zonotrichia leucophrys*	Cr
	Harris' sparrow	*Zonotrichia querula*	Rw
	dark-eyed junco	*Junco hyemalis*	Cw
	lapland longspur	*Calcarius lapponicus*	Rw
	bobolink	*Dolichonyx oryzivorus*	Am
	red-winged blackbird	*Agelaius phoeniceus*	Cr
	western meadowlark	*Sturnella neglecta*	Cr
	yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Us

*Abundance:
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Table B-3. Status of Birds of the Hanford Site, Washington.
(sheet 11 of 11)

Family	Common name	Genus species	Status*
Emberizidae (continued)			
	rusty blackbird	*Euphagus carolinus*	Aw
	Brewer's blackbird	*Euphagus cyanocephalus*	Ur
	brown-headed cowbird	*Molothrus ater*	Ur
	northern oriole	*Icterus galbula*	Us
Fringillidae			
	rosy finch	*Leucosticte arctoa*	Rw
	purple finch	*Carpodacus purpureus*	Aw
	house finch	*Carpodacus mexicanus*	Cr
	common redpoll	*Carduelis flammea*	Aw
	pine siskin	*Carduelis pinus*	Rw
	lesser goldfinch	*Carduelis psaltria*	Am
	American goldfinch	*Carduelis tristis*	Ur
	evening grosbeak	*Coccothraustes vespertinus*	Rw
Passeridae			
	house sparrow	*Passer domesticus*	Cr

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Table B-4. Amphibians and Reptiles Occurring on the Hanford Site (from ERDA 1975).

Common Name	Scientific Name
Amphibians	
Great Basin spadefoot toad	*Spea intermontanus*
Woodhouse's toad	*Bufo woodhouseii*
Pacific treefrog	*Hyla regilla*
Reptiles	
Sagebrush lizard	*Sceloporus graciosus*
Side-blotched lizard	*Uta stansburiana*
Short-horned lizard	*Phrynosoma douglassii*
Striped whipsnake	*Masticophis taeniatus*
Western yellow-bellied racer	*Coluber constrictor*
Gopher snake	*Pituophis melanoleucus*
Desert night snake	*Hyspiglena torquata*
Western rattlesnake	*Crotalus viridis*
Painted turtle	*Chrysemys picta*

Table B-5. Terrestrial Insect Species List (from ERDA 1975).
(sheet 1 of 6)

COLEOPTERA[a]

Anthicidae

- Notoxus sp.

Buprestidae

- Agrilus politus (Say)
- Chrysobothris sp.

Carbidae

- Agonum jejunum LeC.
- Amara sp.
- Calosoma luxatum Say
- Carabus taedutus F.
- Cymindis brevipennis Zimmerman
- Harpalus sp.

Chrysomelidae

- Disonycha alternata Illiger
- Glyptoscelis artemisiae Blake
- Monoxia grisea Blake
- Pachybrachis abdominalis Say
- Phyllotreta sp.

Cicindelidae

- Cicindela oregona LeC.
- Cicindela purpurea Ol.
- Omus californicus Reiche

(a) Only those groups identified to at least generic level are included. Many important invertebrate families are awaiting specific determinations and were excluded from this list.

COLEOPTERA (continued)

Cleridae

- Enoclerus eximius Mann.
- Phyllobaenus sp.

Coccinellidae

- Coccinella novemnotata Herbst
- Hippodamia convergens Guerin
- Hyperaspis elliptica Casey
- Hyperaspis fastidiosa Casey
- Hyperaspis quadrivittata LeC.
- Hyperaspidius vittigera LeC.
- Scymnus intrusoides Hatch
- Scymnus (Pullus) sp.

Curculionidae

- Anthonomus sp.
- Baris sp.
- Cercopedius artemisiae Pierce
- Cleonus trivittatus Say
- Dyslobus alternatus Horn
- Ophryastes cinerascens Pierce
- Sitona californicus Fahr.
- Stamoderes lanei Van Dyke
- Tychius lineelus LeC.

Dermestidae

- Dermestes caninus Germar

Histeridae

- Saprinus sp.
- Saprinus copei Horn

COLEOPTERA (continued)

Meloidae

- Epicauta oregona Horn
- Epicauta normalis Werner
- Epicauta puncticollis Mann.
- Lytta vulnerata cooperi LeC.
- Zonitis vermiculatis schaeffer

Melyridae

- Anthocomus antennatus Hopping
- Anthocomus horni Fall
- Collops hirtellus LeC.
- Collops versatilis Fall

Mordellidae

- Mordellistena aspersa Melsh.

Scarabaeidae

- Aphodius distinctus Muller
- Aphodius fossor L.
- Aphodius granarius L.
- Aphodius haemorrhoidalis L.
- Aphodius hirsutus Brown
- Aphodius washtucna Robinson
- Coenonycha sp.
- Cremastocheilus pugetanus Csy.
- Diplotaxis subangulata LeC.
- Diplotaxis tenebrosa Fall
- Glaresis clypeata Van Dyke
- Onthophagus nuchicornis L.
- Paracotalpa granicollis Haldeman
- Pleurophorus caesus Creutzer

Table B-5. Terrestrial Insect Species List (from ERDA 1975). (sheet 2 of 6)

COLEOPTERA (continued)

Silphidae

Necrophorus marginatus F.

Tenebrionidae

Blapstinus discolor Horn

Blapstinus substriatus Champion

Coniontis lanei Boddy

Coniontis ovalis Ulke

Coniontis setosa Casey

Conisattus nelsoni Boddy

Eleodes granulata LeC.

Eleodes hispilabris imitabilis Blais.

Eleodes humeralis LeC.

Eleodes nigrina difformis Blais.

Eleodes novoverrucula Boddy

Eleodes obscura Say

Eusattus muricatus LeC.

Oxygonodera hispidula Horn

Philolithus densicollis Horn

Stenomorpha puncticollis LeC.

COLLEMBOLA

Isotomidae

Isotoma viridis Bourlet

Sminthuridae

Bourletiella hortensis Fitch

DIPTERA

Acroceridae

Eulonchus n. sp.

Anthomyiidae

Hylemya cinerella Fallen

Hylemya neomexicana Malloch

Scatophaga furcata Say

Scatophaga stercoraria L.

Apioceridae

Apiocera sp.

Asilidae

Ablautus colei Wilcox

Cyrtopogon sp.

Cyrtopogon ablautoides Melander

Dioctria sp.

Efferia albibarbis Macquart

Efferia benedicti Bromley

Efferia coulei Wilcox

Efferia harveyi Hine

Lasiopogon chaetosus Cole and Wilcox

Leptogaster sp.

Lestomyia n. sp.

Myelaphus sp.

Nicocles utahensis Banks

Proctacanthus sp.

Promachus sp.

Scleropogon neglectus Bromley

DIPTERA (continued)

Asilidae (continued)

Stenopogon inquinatus Loew

Stenopogon martini Bromley

Tolmerus sp.

Bombyliidae

Conophorus obesulus Loew

Villa sp.

Calliphoridae

Calliphora vicina R.-D.

Phormia regina Meigen

Cecidomyiidae

Lestremia sp.

Ceratopogonidae

Culicoides crepuscularis Mall.

Chironomidae

Cricotopus sp.

Tanytarsus sp.

Chloropidae

Hippelates pusio Loew

Meromyza nigriventris Macquart

Oscinella carbonaria Lw.

Thaumatomyia appropinqua Ad.

Thaumatomyia glabra Mg.

Ephydridae

Hydrellia griseola Fallen

Philygria debilis Lw.

Scatella stagnalis Fallen

Table B-5. Terrestrial Insect Species List (from ERDA 1975).
(sheet 3 of 6)

DIPTERA (continued)

Milichiidae

Leptometopa halteralis Coq.

Muscidae

Fannia sp.

Musca domestica L.

Schoenomyza dorsalis Loew

Mycetophilidae

Docosia sp.

Nemestrinidae

Neorhyncocephalus sackenii Williston

Otitidae

Ceroxys latiusculus Loew

Physiphora demandata F.

Sarcophagidae

Blaesoxipha falciformis Aldrich

Helicobia rapax Walker

Ravinia lherminieri R.D.

Sarcophaga sp.

Senotainia sp.

Taxigramma heteroneura Meigen

Scenopinidae

Brevitrichia sp.

Scenopinus whittakeri James

Sciaridae

Bradysia sp.

DIPTERA (continued)

Sepsidae

Sepsis neocynipsea Melander and Spuler

Stratiomyidae

Nemotelus sp.

Syrphidae

Eristalis tenax L.

Metasyrphus meadii Jones

Scaeva pyrastri L.

Syrphus opinator Osten Sacken

Syrphus torrus Osten Sacken

Tachinidae

Acemya sp.

Alophorella sp.

Catagoniopsis sp.

Euphorocera sp.

Exorista mella Wlk.

Gonia frontosa Say.

Ostracophyto aristalis Tns.

Peleteria sp.

Periscepsia cinerosa Coq.

Periscepsia helymus Wlk.

Procatharosia calva Coq.

Stomatomyia parvipalpis Wulp

Uclesia retracta Ald.

Tephritidae

Euaresta tapetis coquillett

Oxyna utahensis Quisenberry

DIPTERA (continued)

Therevidae

Psilocephala baccata Coquillett

Thereva sp.

Tipulidae

Tipula (Lunatipula) dorsimacula Walker

Trixoscelididae

Trixoscelis sp.

HEMIPTERA

Coreidae

Leptoglossus occidentalis Heidemann

Lygaeidae

Neosuris castanea Barber

Miridae

Stenodema vicinum Prov.

Reduviidae

Zelus sp.

Saldidae

Saldula sp.

HOMOPTERA

Cicadellidae

Aceratagallia sp.

Ballana sp.

Carsonus aridus Ball

Circulifer tenellus Baker

Table B-5. Terrestrial Insect Species List (from ERDA 1975). (sheet 4 of 6)

HOMOPTERA (continued)

Cicadellidae (continued)

- Collandonus germinatus Van Duzee
- Commellus sexvittatus Van Duzee
- Dikraneura carneola Stal.
- Empoasca neaspera Oman and Wheeler
- Empoasca nigra Gillette and Baker
- Errhomus n. sp.
- Psammotettix sp.
- Sorhoanus debilis Uhler
- Texananus extremus Ball
- Xerophloea peltata Uhler

icadidae

- Okanagana utahensis Davis

rthezlidae

- Orthezia sp.

seudococcidae

- Trionymus winnemucae McKenzie

HYMENOPTERA

phidiidae

- Lysiphlebus sp.

Argidae

- Schizocerella pilicornis Holmgren

Braconidae

- Agathis sp.
- Apanteles sp.
- Bracon gelechiae Ashm.

HYMENOPTERA (continued)

Braconidae (continued)

- Cremnops californicus Morr.
- Microctonus sp.
- Microplitis sp.
- Orgilus strigosus Mues.

Bethylidae

- Epyris cochise Evans

Ceraphronidae

- Ceraphron sp.

Chrysididae

- Ceratochrysis sp.
- Chrysis sp.
- Chrysura sp.

Encyrtidae

- Copidosoma sp.

Eulophidae

- Euderus sp.
- Tetrastichus coerulescens Ashmead

Eumenidae

- Pterocheilus decorus Cresson
- Pterocheilus provancheri Huard
- Stenodynerus sp.

Eurytomidae

- Bruchophagus sp.
- Harmolita sp.

HYMENOPTERA (continued)

Formicidae

- Camponotus semitestaceus Emery
- Camponotus vicinus Mayr
- Formica manni Wheeler
- Formica neogagates Emery
- Formica subpolita camponoticeps Wheeler
- Lasius crypticus Wilson
- Lasius sitkaensis Pergande
- Monomorium pharaonis L.
- Myrmecocystus testaceus Emery
- Pheidole californica oregonica Emery
- Pheidole creightoni Gregg
- Pogonomyrmex owyheei Cole
- Solenopsis molesta validiuscula Emery
- Tapinoma sessile Say

Ichneumonidae

- Anomalon sp.
- Campoletis sp.
- Diphyus sp.
- Diolazon laetatorius F.
- Erigorgus sp.
- Euryproctus sp.
- Lissonota sp.
- Meringopus dirus Prov
- Ophion sp.
- Pterocormus sp.
- Temelucha sp.

Table B-5. Terrestrial Insect Species List (from ERDA 1975). (sheet 5 of 6)

HYMENOPTERA (continued)

Mutillidae

- Odontophotopsis sp.
- Sphaeropthalma (Photopsis) sp.

Pompilidae

- Aporinellus sp.
- Episyron snowi Vierock
- Pompilus (Ammosphex) sp.
- Priocnemis oregona Banks
- Tachypompilus torridus unicolor Banks

Pteromalidae

- Gastrancistrus aphidis Girault
- Mesopolobus sp.

Scelionidae

- Gryon sp.

Sphecidae

- Ammophila aberti Haldeman
- Ammophila azteca Cameron
- Ammophila karenae Menke
- Ammophila mcclayi Menki
- Cerceris sp.
- Pidalonia mexicana Saussure
- Podalonia luctuosa Smith
- Podalonia valida Cresson
- Prionyx atratus Lepeletier
- Sphecius grandis Say
- Stictiella emarginata Cresson
- Stizoides unicinctus Say

HYMENOPTERA (continued)

Sphecidae (continued)

- Tachysphex sp.
- Tachytes californicus Bohart
- Tachytes distinctus Smith

Tiphiidae

- Brachycistis sp.

Vespidae

- Polistes fuscatus F.
- Vespula pensylvanica Saussure

ISOPTERA

Rhinotermitidae

- Reticulitermes hesperus Banks

LEPIDOPTERA

Arctiidae

- Apantesis sp.

Coleophoridae

- Coleophora sp.

Gelechiidae

- Aroga rigidae Clarke
- Chionodes sp.

Noctuidae

- Euxoa sp.
- Feltia ducens Walker
- Feltia Herilis Grote
- Feltia subgothica Haworth

LEPIDOPTERA (continued)

Noctuidae (continued)

- Lacinipolia pensilis Grote
- Nephelodes emmedonia Cramer
- Rhynchagrotis sp.
- Schinia sp.
- Spaelotis clandestina Harris
- Ufeus hulsti J. B. Smith

Pyralidae

- Crambus attenuatus Grote
- Crambus whitemerellus Klots

Saturniidae

- Hemileuca hera Harris

Scythridae

- Scythris sp.

Tischeriidae

- Coptotriche sp.

NEUROPTERA

Arctiidae

- Apantesis sp.

Chrysopidae

- Chrysopa coloradensis Bks.
- Chrysopa excepta Bks.
- Eremochrysa tibialis Bks.

Myrmeleontidae

- Paranthaclisis congener Hag.

Table B-5. Terrestrial Insect Species List (from ERDA 1975).
(sheet 6 of 6)

NEUROPTERA (continued)

Raphidiidae

- Agulla bicolor Alb.

ORTHOPTERA

Acrididae

- Ageneotettix deorum Thomas
- Amphitornus coloradus Thomas
- Arphia pseudonietana Thomas
- Aulocara elliotti Thomas
- Circotettix undulatus Thomas
- Conozoa wallula Scudder
- Cratypedes neglectus Thomas
- Dissosteira carolina L.
- Melanoplus bivittatus Say
- Melanoplus cinereus cinereus Scudder
- Melanoplus sanguinipes sanguinipes F.
- Oedaleonotus enigma Scudd.
- Paropomala pallida Bruner
- Psoloessa delicatula buckelli Rehn
- Trimerotropis caeruleipennis Bruner
- Trimerotropis fontana Thomas
- Trimerotropis gracilis sordida Walker
- Trimerotropis pallidipennis pallidipennis Burmeister
- Trimerotropis sparsa Thomas
- Xanthippus lateritius Sauss.

Gryllacrididae

- Ceuthophilus vicinus Hubbell

ORHTOPTERA (continued)

Gryllidae

- Gryllus sp.
- Oecanthus argentinus Sauss.
- Oecanthus quadripunctatus Beutenmuller

Mantidae

- Litaneutria minor Scudd.

Tettigoniidae

- Steiroxys sp.

PSOCOPTERA

Liposcelidae

- Liposcelis sp.

TRICHOPTERA

Hydroptilidae

- Hydroptila xera Ross

Hyrodpsychidae

- Cheumatopsyche campyla Ross

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